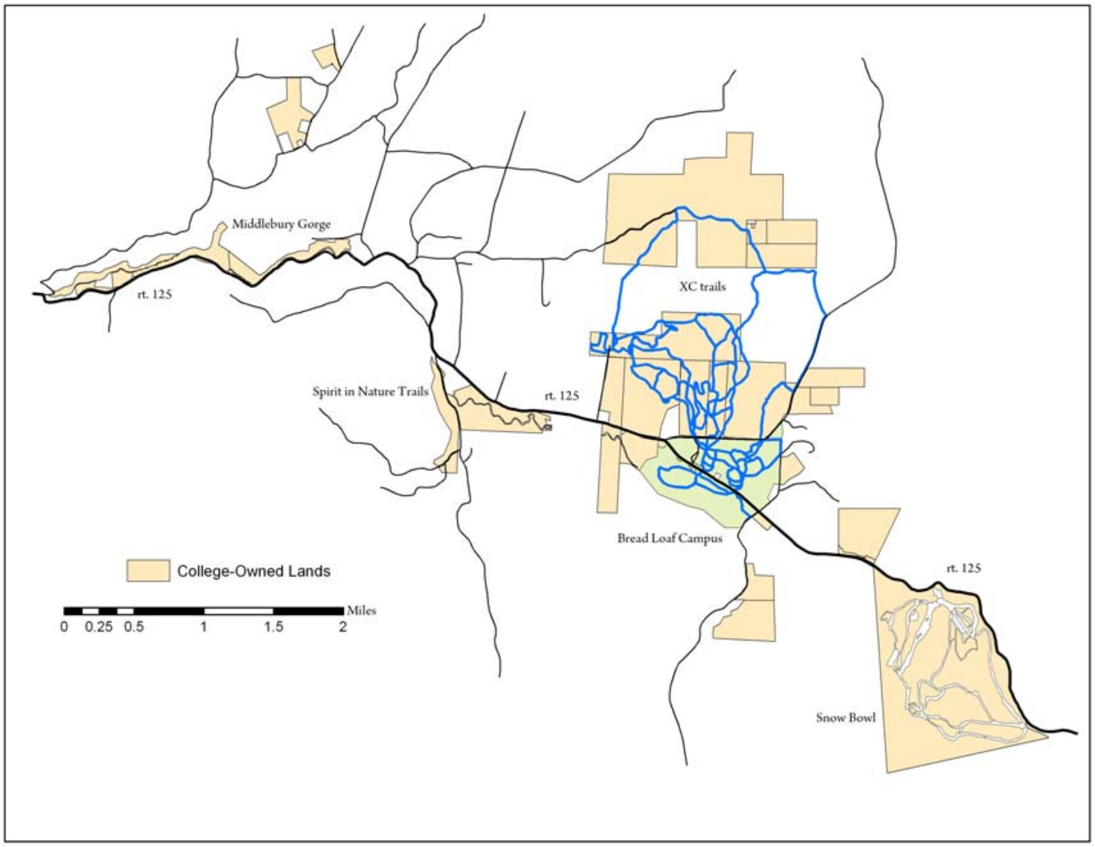
Middlebury College



Conservation Assessment of Current and Potential Uses for Middlebury College Bread Loaf Lands

Management Unit: Bread Loaf Lands, including the following lots: Battell Park, Bread Loaf, Brooks Schoolhouse, Bridgman and Wimet, Brown, Burdick, Coal Kiln, Crystal Brook, Edwards, Gibeault, Goshen Brook, Homer Noble Farm, MMMF, Myhre, Norton, Snow Bowl, Spear, Upson, USFS Exchange, and Women's Athletic Association (WAA) Lots.

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Strengthening Middlebury College's Environmental leadership and reputation through continued good stewardship of College landholdings.

Environmental Studies Senior Seminar, Middlebury College, December 2008

Acknowledgements

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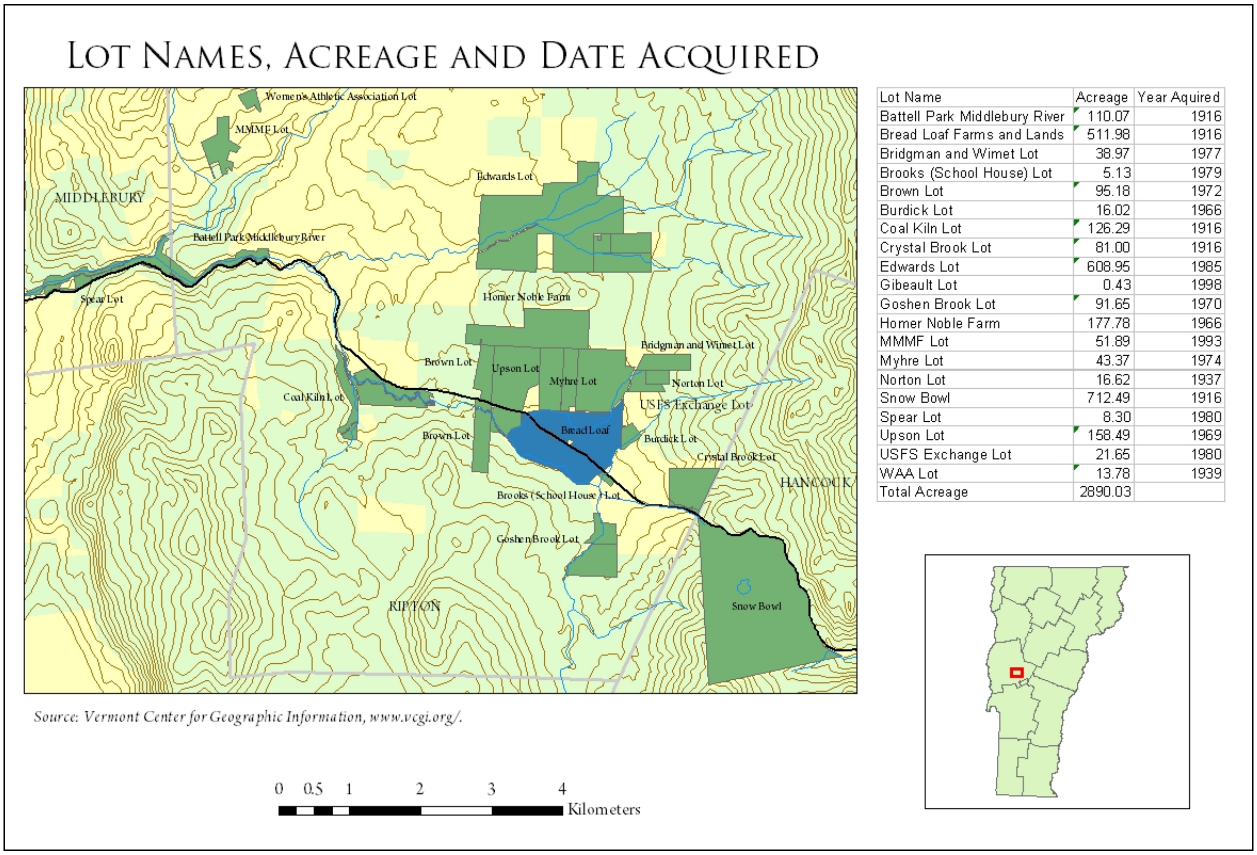
I. Executive Summary


LOT NAMES, ACREAGE AND DATE ACQUIRED

Lot Name	Acreage	Year Aquired
Battell Park Middlebury River	110.07	1916
Bread Loaf Farms and Lands	511.98	1916
Bridgman and Wimet Lot	38.97	1977
Brooks (School House) Lot	5.13	1979
Brown Lot	95.18	1972
Burdick Lot	16.02	1966
Coal Kiln Lot	126.29	1916
Crystal Brook Lot	81.00	1916
Edwards Lot	608.95	1985
Gibeault Lot	0.43	1998
Goshen Brook Lot	91.65	1970
Homer Noble Farm	177.78	1966
MMMF Lot	51.89	1993
Myhre Lot	43.37	1974
Norton Lot	16.62	1937
Snow Bowl	712.49	1916
Spear Lot	8.30	1980
Upson Lot	158.49	1969
USFS Exchange Lot	21.65	1980
WAA Lot	13.78	1939
Total Acreage	2890.03	

Source: Vermont Center for Geographic Information, www.vcgi.org/.

Figure 1. Lot names, acreage and date acquired

Middlebury College owns a total of 2,890 acres in Ripton, Hancock and East Middlebury, comprised of 20 parcels in a biophysical community known as the Northern Green Mountains (Figure 1). These parcels straddle the ridgeline of the Green Mountains and range from 547 ft to 2,838 ft above sea level in elevation. The Northern Green Mountains are characterized by high elevations, cool summer temperatures, and acidic metamorphic rocks (Thompson and Sorenson, 2000). Northern Hardwood Forests and the high elevation communities of the Spruce-Fir Northern Hardwood Forest Formation are also characteristic of this area (Thompson and Sorenson, 2000). Appendix 2 has more specific land cover data.

As outlined by the Land Stewardship Initiative (2008), these lands represent "a significant and largely untapped opportunity" to "strengthen [the College's] environmental leadership and reputation" (Planning Steering Committee and President's Staff, 2006). By continuing to steward these lands well and exploring potential goals in a manner that integrates student and faculty research, the College can significantly expand its knowledge of these lands and create a model for land stewardship to be followed by similar institutions. In conjunction with the College's commitment to clean energy, a renewed dedication to land stewardship would set a higher standard for liberal arts colleges that own significant amounts of land. By "formally recognizing the important contributions that the College's landholdings make to the education of students, the research of students and faculty, and local and regional sustainability," as suggested by the Land Stewardship Initiative, the College stands to gain in a number of different areas.

Community Outreach: The College has made a commitment to "strengthen its reputation for institutional leadership through outreach at the state…level" (Planning Steering Committee and President's Staff, 2006). As a significant land owner in the town of Ripton, the College has an opportunity to foster a particular land ethic amongst community members and within the College community. Continuing to allow for recreational and spiritual use of these lands by the general public, and contributing to energy assistance programs such as the Ripton Energy Assistance Program (REAP), will permit the College to offer a deeper sense of connection with the land that will cultivate a community land ethic.

Energy: The College can pursue two of the recommendations outlined in the Strategic Plan by encouraging student and faculty to research the potential for clean energy production on the landholdings at Bread Loaf. Recommendation #69 references "a demonstrated commitment to research, test and utilize alternative energy sources." Pursuing this commitment on the Bread Loaf lands could significantly contribute to the effort to reduce the carbon footprint of the College's auxiliary operations. Recommendation #68 calls for the continuation of an "exemplary education that incorporates…research and applied experience." The ability to understand and test for conditions suitable for alternative energy will be increasingly important in a world that needs to make the switch from fossil fuels to renewable energy.

Green Certification: The first step toward green certification would be to develop a comprehensive forest conservation plan. According to David Brynn of Vermont Family Forests (VFF), the development of such a plan would bring to light the myriad ecological functions and values offered by the College's holdings, as well as the potential for timber production on those lands (pers. comm. 2008). Four of the College's 20 parcels are already certified by the Forest Stewardship Council (FSC) and enrolled in VFF. A careful inventory of the remaining parcels could not only provide a considerable opportunity for student and faculty research, but would also be the first step toward a new organic forest certification that will soon be offered by VFF. Once this is completed, the College can decide whether or not to move ahead with the certification process. Enrolling all forested parcels in VFF and certifying them under FSC would serve to further the College's reputation as an environmental pioneer.

Carbon Sequestration: Investigating the potential for carbon sequestration would contribute to the College's goal of carbon neutrality and provide a host of research opportunities. Land management practices that promote carbon sequestration are still in the process of being developed, and students and faculty would therefore be involved in progressive research that is extremely relevant given the potentialities of climate change.

Undergraduate Experience: Woven throughout all of these areas of investigation is the opportunity to increase local research and applied experience within the curriculum. The research opportunities are not limited to Environmental Studies majors. As demonstrated by this current project, there is ample opportunity for a wide variety of academic fields to utilize the College landholdings in Ripton, Hancock and East Middlebury as educational resources.

Encouraging student interaction with forested lands will also cultivate a valuable land ethic in students, essential to decision making as both local and global leaders.

In order to convey these opportunities to the College community, we have prepared this report for the Lands Stewardship Advisory Group. With it, we hope to illustrate the ways in which the College could strengthen its environmental leadership and reputation by continuing and expanding its responsible stewardship of landholdings. It should be noted here that given the scope of this project, we have only been able to skim the proverbial surface of the opportunities available. As the College deepens its understanding of these lands, both further opportunities and challenges will be brought to light. We hope that this report serves as a starting point that offers a sense of the possibilities the College might pursue.

In this report we also reiterate the importance of the Land Stewardship Advisory Group. As outlined in the Land Stewardship Initiative, "the Board of Trustees, with the advice and support of the Administration, holds the ultimate, non-delegable responsibility and authority for management of the College's land and resources." We see the Advisory Group, therefore, as an entity that serves to integrate the ideas, opinions and the wealth of intellectual capital of the many stakeholders in the management of the College lands, including students, staff and faculty. The group will collaborate to develop proposals for future uses of the lands, and, when necessary, present them to the Board of Trustees via Bob Huth, Vice President and Treasurer, in order to facilitate environmentally and fiscally responsible decisions regarding the College's landholdings.

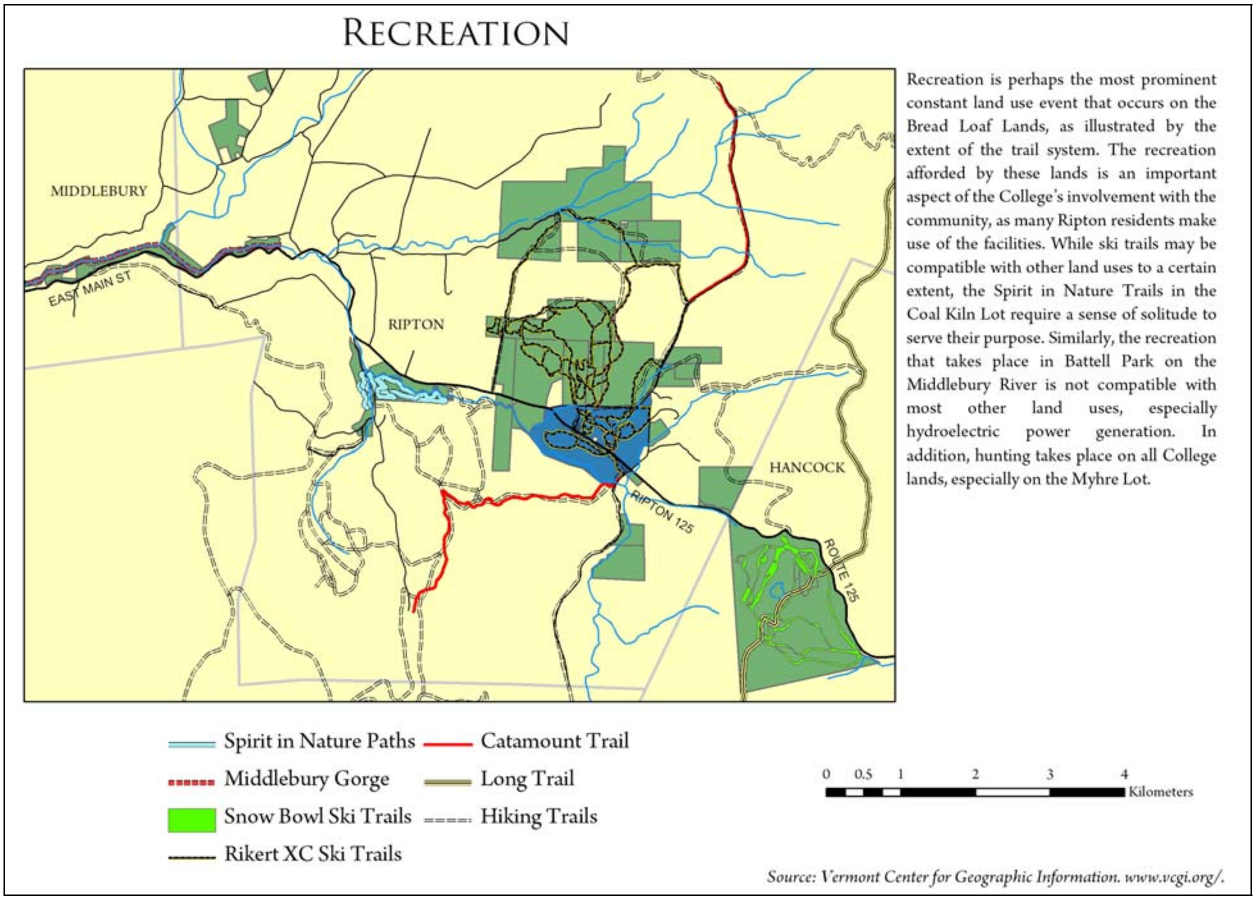
The continued good stewardship of the College lands in Ripton, Hancock, and East Middlebury stands to reinforce the College's commitment to environmental leadership and exemplary education. It is with this vision that we proudly present the following report.

Project Context

The College's lands at Bread Loaf are valuable assets that offer numerous resources and boundless opportunities for exploration. This report to the Land Stewardship Advisory Group provides an assessment of the current use of these lands and proposes suggestions for the continuation of responsible management in the future. Compiled by six Middlebury College Environmental Studies majors, the report draws from backgrounds in the natural sciences, the social sciences and literature. Working under the supervision of Nan Jenks-Jay and Diane Munroe in the context of a senior seminar on "New Models for Land Stewardship," we have learned valuable lessons from contemporary conservation literature and profited from a wealth of local knowledge. As we researched the Bread Loaf lands for this report, we were fortunate enough to be able to draw much of the information that we needed from the vast resources and many knowledgeable faculty and staff members of Middlebury College. Given the time and resource constraints of a semester-long course, we have focused our attention on compiling ideas and information rather than implementing specific policies. We hope that this report serves as a starting point for future College and local community initiatives that enable the Bread Loaf lands to realize their full potential.

II. Current Land Use

A. **Recreation**



RECREATION

Recreation is perhaps the most prominent constant land use event that occurs on the Bread Loaf Lands, as illustrated by the extent of the trail system. The recreation afforded by these lands is an important aspect of the College's involvement with the community, as many Ripton residents make use of the facilities. While ski trails may be compatible with other land uses to a certain extent, the Spirit in Nature Trails in the Coal Kiln Lot require a sense of solitude to serve their purpose. Similarly, the recreation that takes place in Battell Park on the Middlebury River is not compatible with most other land uses, especially hydroelectric power generation. In addition, hunting takes place on all College lands, especially on the Myhre Lot.

Source: Vermont Center for Geographic Information. www.vcgi.org/.

Figure 2. Recreation

Recreation is a crucial component of the current land use scheme of the College landholdings in Ripton, Hancock and East Middlebury. The College community and the general public use the lands for nordic and alpine skiing, hiking, hunting and spiritual uses; the extent of these activities are illustrated in Figure 2. There are 27.1 Km of recreational trails not owned or maintained by the College that run through the College lands, including hiking trails, the Catamount nordic ski trail, and the Long Trail. In addition to these 27.1 Km, the College owns the Rikert Ski Center, offering 42 Km of trails, and the Snow Bowl, with 110 acres of open terrain.

Rikert Ski Touring Center

The Rikert Ski Touring Center transforms the Bread Loaf lands into a community hub during the winters (Reilly, pers. comm. 2008). It is one of two Ski Touring Centers in Addison County, the other being the Blueberry Hill Cross Country Ski Center. Blueberry Hill in Goshen is proximate to Rikert, however it caters to the tourist population as a result of its on-site lodging and its destination feel. Conversely, Rikert's easily accessible location and casual atmosphere create a place for local residents and members of the College community to meet, socialize, and recreate.

Because of this atmosphere and ease of access, 10 local schools utilize Rikert for physical education classes, and in this capacity Rikert serves about 350 children a week. The Middlebury Union High School and Middle School Ski Teams also use the facility to practice, comprising an additional 60 to 80 young adults. Other community groups that utilize the space are the Frost Mountain Nordic Club, which organizes a weekly race series, the Special Olympics, and the Bill Koch League, the latter comprised of about 40 children. The Catamount Ski Association, a state-wide group, also makes use of the facility a few times a year.

In addition to this strong non-College community presence, the College community also uses the facility on a regular basis. The staff estimate between 200-300 skier visits a month from the College community, and this figure has been on the rise as a result of the new Addison County Transit Resources (ACTR) schedule. This figure does not take into account the Middlebury College Nordic Ski Team, which practices at Rikert. The Rikert Ski Touring Center, therefore, is one way that the College currently encourages connections to the land within both the College and local communities, an important aspect of stewardship.

Middlebury College Snow Bowl

The Snow Bowl is in many ways similar to Rikert, especially in that it also serves as a community hub (Davis, pers. comm. 2008). The two facilities work in conjunction due to their proximity; it is easy to drop off a family member at either facility and then recreate at the other. The Snow Bowl is the only alpine skiing facility in Addison County.

The Snow Bowl experiences 13-15,000 day visits per season, and 90% of those are by non-College community members (Mackey, pers. comm. 2008). The facility provides training for the Middlebury Ski Club, Middlebury Union High School ski team and the Green Mountain Valley School ski team. Staff estimate about 500 private lessons a season, and from 500 to 600 group lessons (Davis, pers. comm. 2008). These figures illustrate the importance of the Snow Bowl as a heavily utilized one-of-a-kind facility in Addison County.

Spirit in Nature Trails

The Spirit in Nature Trails, located on the 126 acres of the Coal Kiln Lot along Route 125 and accessed by Goshen Road, function as a unique place of worship and spirituality in a woodland setting. They encourage interfaith connections with the ultimate goal of community education (Spooner, pers. comm. 2008). The trail sees three to five thousand visitors a year, and the Spirit in Nature (SpIN) organization works closely within the College community. Each year at least two to three students are members of the SpIN board of directors. With 10 different trails, the organization hopes to "strengthen the response of traditional religious communities to the current environmental crisis." SpIN serves as a model for fostering a community land ethic by tapping into religious beliefs.

Long Trail

The Long Trail, built between 1910 and 1930, is the oldest long-distance hiking trail in the United States, spanning 270 miles from the southwest corner of Vermont to the Canadian border (Rose, pers. comm. 2008). It runs along the main ridge of the Green Mountains, and through the middle of the Snow Bowl parcel in Hancock, which is protected by Joseph Battell's Last Will. The document stipulates (1 March 1913): "Said lands… [are to be held] in trust as a park for the benefit…of said Middlebury College and the students thereof…It is a condition of this devise that said trustees shall at reasonable times and under reasonable regulations…allow the citizens of Vermont and visitors within her limits, access to said park and enjoyment of the privileges thereof."

Statewide, the Long Trail sees around 200,000 hikers a year, and a day hike to Lake Pleiad is a particularly popular route. In addition, there are around 200 hikers who pass through these lands every year in order to complete the entire trail. The Long Trail therefore represents a long history of outdoor recreation at the state level and Middlebury College has contributed to that history by allowing public access through a licensing agreement renewed every five years. Middlebury College is one of the few remaining land owners to require a renewal of public rights on a rotating basis. Only 1.8% of the Long Trail runs through land without an easement. The Snow Bowl lands account for 20% of that land.

Catamount Trail

The Catamount Trail is a cross-country ski trail, completed in 2008, that runs the entire length of Vermont and through the College lands at Bread Loaf. The Middlebury College community has been pivotal in the construction of the trail. That the Rikert Ski Touring Center is used by the Catamount Ski Association as a beginning or end for their tours is indicative of the collaborative partnership.

Middlebury Gorge

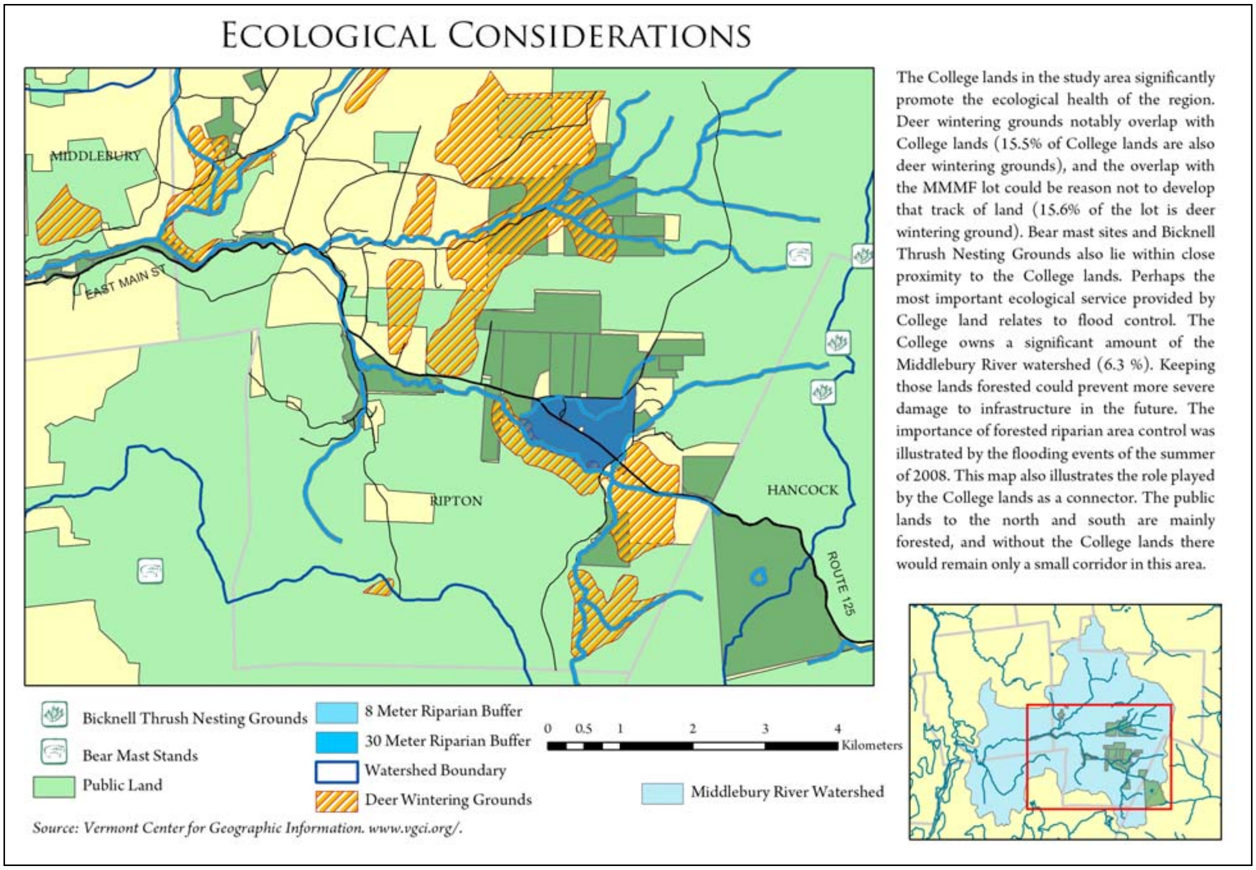
The Middlebury Gorge is a unique natural area boasting incredible views, unparalleled geologic formations, and many recreation opportunities. There are no usage statistics on this park, also protected by Battell's Last Will with the same language as the Snow Bowl, but a number of students and visitors make use of the area during the warmer months. The gorge itself is an impractical site for hydroelectric electricity production, the creation of which would also interfere with recreational uses.

Hunting

Hunting takes place on all Middlebury College lands in Ripton, Hancock and East Middlebury (Collitt, pers. comm. 2008), especially on and near the Myhre Cabin on the Myhre Lot.

As illustrated by this record of activities taking place on College lands, recreation is an extremely prominent current use of the Bread Loaf lands. Continuing to encourage recreation by the College and local communities will further cultivate a connection between those communities and the land. In this manner, the College can help foster a community land ethic among its students and in the larger community that spreads beyond Addison County.

B. Ecological Considerations



The College lands in the study area significantly promote the ecological health of the region. Deer wintering grounds notably overlap with College lands (15.5% of College lands are also deer wintering grounds), and the overlap with the MMMF lot could be reason not to develop that track of land (15.6% of the lot is deer wintering ground). Bear mast sites and Bicknell Thrush Nesting Grounds also lie within close proximity to the College lands. Perhaps the most important ecological service provided by College land relates to flood control. The College owns a significant amount of the Middlebury River watershed (6.3 %). Keeping those lands forested could prevent more severe damage to infrastructure in the future. The importance of forested riparian area control was illustrated by the flooding events of the summer of 2008. This map also illustrates the role played by the College lands as a connector. The public lands to the north and south are mainly forested, and without the College lands there would remain only a small corridor in this area.

Source: Vermont Center for Geographic Information. www.vgci.org/.

Figure 3. Ecological Considerations

Maintaining the landholdings in Ripton, Hancock and East Middlebury as forested lands has played a significant role in the ecological health of the region. These ecological considerations are explored in more depth in the section entitled “Ecological Services.”

Natural Region of the Bread Loaf lands

The Northern Green Mountains are characterized by high elevations, cool summer temperatures, and acidic metamorphic rocks (Thompson and Sorenson, 2000). Northern Hardwood Forests and the high elevation communities of the Spruce-Fir Northern Hardwood Forest Formation are also characteristic (Thompson and Sorenson, 2000).

With its high mountains, cold winters, and short growing season, the Northern Green Mountains have remained one of the least populated regions of Vermont for most of its inhabited history (Thompson and Sorenson, 2000). The river valleys, with their good agricultural soils, have provided a notable exception to this pattern (Thompson and Sorenson, 2000). Within the last 75 years, much more extensive development of the region has occurred, chiefly related to downhill ski areas (Thompson and Sorenson, 2000). The region still has one of the lowest road densities in the state and the second highest percentage of land in public ownership of any biophysical region other than the Southern Green Mountains (Thompson and Sorenson, 2000).

The Northern Green Mountains provide the best examples of many high elevation and boreal communities in Vermont (Thompson and Sorenson, 2000), which are particularly susceptible to environmental stressors, such as climate change and acid rain (Lloyd, pers. Comm.. 2008). Northern Harwood Forests and Hemlock Forests occur on the lower slopes, such as in the Middlebury Gorge and the Bread Loaf Campus (Lloyd, pers. comm. 2008). Montane Yellow Birch-Red Spruce Forest occurs on mid-slopes at the bottom of the Snow Bowl, while Montane Spruce-Fir Forest occurs at the top of the Snow Bowl (Lloyd, pers. comm. 2008). Northern Hardwood Forest is by far the dominant species in the area (Thompson and Sorenson, 2000; Lloyd, pers. comm. 2008).

The Northern Green Mountains provide extensive habitat for many species of mammals, including black bear, white-tailed deer, bobcat, fisher, beaver, and red squirrel (Thompson and Sorenson, 2000). Several species of birds, typically characteristic of high elevation forests, such as Swainson's Thrush and the rare Bicknell's Thrush, also inhabit the biophysical region (Thompson and Sorenson, 2000).

Connectivity

As illustrated by Figure 3, the College lands significantly contribute to the connectivity of wooded areas within the Middlebury River watershed. Route 125 creates a barrier for many species, but the College lands create a rather wide corridor for species able to cross the road.

Forested Riparian Areas

In the Middlebury River Watershed, there are 811.18 acres of 30 meter riparian buffer. Of that, 250.06 acres, or 30.8%, lie within College lands. Please refer to the section on ecosystem services for a discussion of the importance of forested riparian buffers.

Wildlife Habitat

College landholdings are located in close proximity to important wildlife habitat. As illustrated in Figure 3, Bicknell's Thrush nesting grounds and bear masts are located on adjacent parcels of land. The College plays a direct role in these adjacent parcels because increased disturbance in Vermont forests, usually from human sources, has been shown to increase the number of brown-headed cowbirds (*Molothrus ater*) – an invasive non-native species – and decrease native species, such as the Bicknell's Thrush, designated a species of conservation concern by the National Audubon Society (Coker and Capen, 1995). In addition, a significant portion of the Middlebury College lands in the area (15.5%) serve as deer wintering grounds. Please refer to the section on ecosystem services for a discussion of the importance of this habitat and of these species.

By committing to keeping these landholdings forested, the College has positively impacted the ecological health of the region. Student and faculty research into the ecological services offered by the College lands would enable the College to better understand the importance of such ecological services and values of these lands, and to continue making wise stewardship decisions.

Past Ecological Work

Barry Schultz and Warren King, local naturalists in Ripton, have kept data on the National Audubon Society's Annual Birdathon and have counted a total of 163 species on College land and in the Ripton area since 1990 (Table 1).

Kate LaRiche, an Environmental Studies major, conducted a biological inventory of the North Bread Loaf Forest for her senior thesis in 1998. She investigated trees, small mammals, other mammals that left signs of their presence, aquatic insects, small fish, and birds. She captured or found signs from a total of 54 species of birds and mammals, 3 orders of aquatic invertebrates, and 1 genus of small fish (Table 1). Combining her observations with the National Audubon Society's Annual Birdathon data since 1990 demonstrates at least 198 species in the area. However, her count most likely underestimates that number, due to seasonal trapping and one-year thesis time limitations. She recommended that another biological inventory, including one analyzing all taxa that use the area, be conducted at some point in the future.

Type of animal or plant	Method of Observation	Number Observed
Trees	Sample	17
Small mammals	Capture	4
Mammals	Sign Observed	10
Birds	LaRiche Observation	19
Birds	Audubon Observation	144
Total Species	LaRiche alone	54
Total Species	LaRiche and Audubon	198
Total Orders of Aquatic Invertebrates	Capture	3
Total Geni of Small Fish	Capture	1

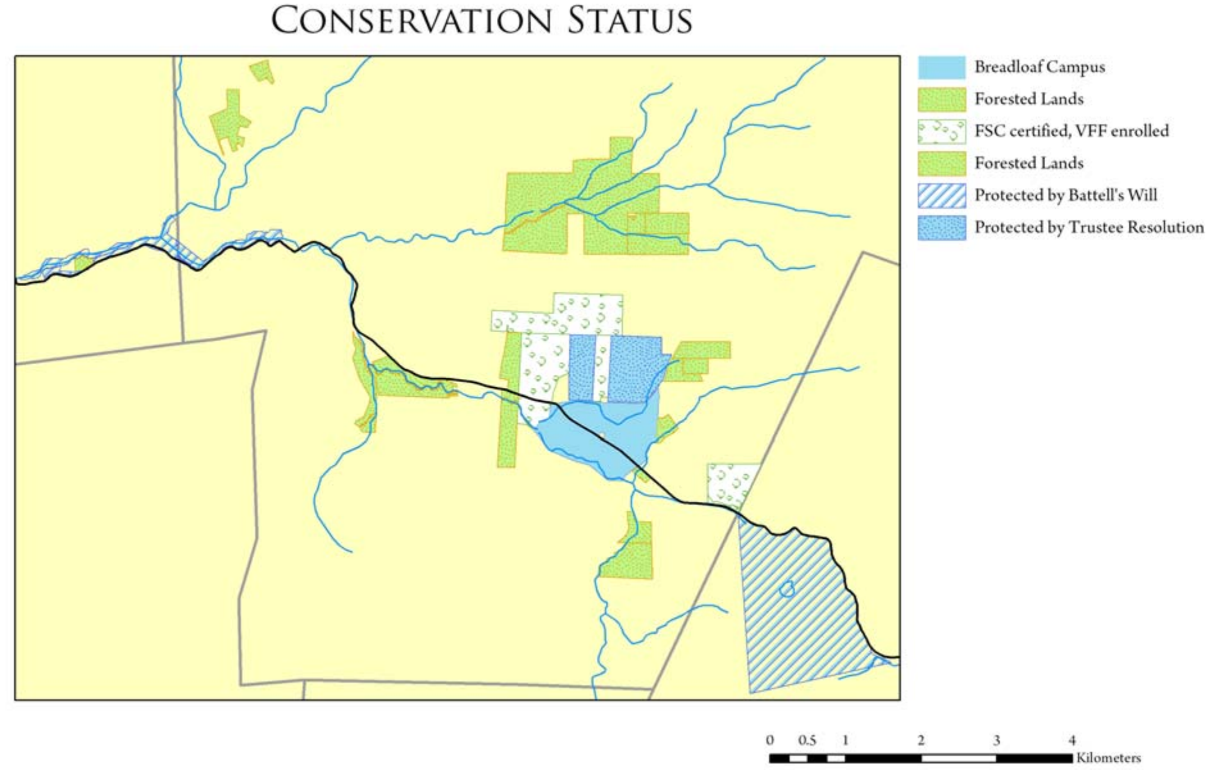
Table 1. Species on College land and in Ripton area

Another of her recommendations was that the College should establish a physical space designated for undergraduate research in the Bread Loaf area. From this space, important tools, such as a bird observatory or a weather station, could be built and maintained, enhancing research opportunities. She noted that the Bread Loaf Forest offered an abundance and variety of habitat and myriad opportunities for further research.

Caitlyn Long, another Environmental Studies major, studied acid precipitation and nutrient cycling in the Bread Loaf Area from the Fall of 2004 to the Spring of 2005 for her thesis work. She found that the Bread Loaf area is receiving acid precipitation and experiencing a significant amount of associated nutrient leaching from the soil. These changes primarily affect sugar maple and northern hardwood stands (Miller et al., 2003), species of prime economic importance to Vermont for both the sugaring and timber industries. However, she found no evidence that the area has reached nitrogen saturation – a complex suite of changes occurs as nitrogen deposition increases, ultimately leading to forest decline and soil acidification (Ågren and Bosatta, 1988; Aber et al., 1989; Aber, 1992; Aber et al., 1998). So while negative effects from acid precipitation are being experienced in the Bread Loaf area, they have not reached a possible worst-case scenario. She does note, however, that while no adverse effects on organisms in the watershed are expected in the near future, adverse effects are generally delayed until after nitrification, soil acidification and cation depletion, none of which have occurred. She mentioned that protecting the numerous wetlands in the area will be critical to mitigating the effects of acid rain. She also recommended that year round data should be collected to continue to monitor the situation, with which a year round field station would help.

Andi Lloyd, Associate Professor of Biology at Middlebury College, has ongoing research on recruitment of new trees after logging on Bread Loaf parcels.

C. Conservation Status and Green Certification


CONSERVATION STATUS
Breadloaf Campus
Forested Lands
FSC certified, VFF enrolled
Forested Lands
Protected by Battell's Will
Protected by Trustee Resolution
0
0.5
1
2
3
4
Kilometers

Source: Personal Communications with Steve Weber, 11 November 2008 and David Brynn 12 November 2008. Battell, J. et al. 1913 The Last Will of Joseph Battell. *1 March 1913. Vermont Center for Geographic Information. www.vgci.org/.*

Figure 4. Conservation Status

Two parcles (822.56 acres) are protected by Joseph Battell's Last Will (Figure 4) with the language quoted earlier: "Said lands… [are to be held] in trust as a park for the benefit…of said Middlebury College and the students thereof…It is a condition of this devise that said trustees shall at reasonable times and under reasonable regulations…allow the citizens of Vermont and visitors within her limits, access to said park and enjoyment of the privileges thereof." Two parcels (218.84 acres) are protected by a trustee resolution with the same language, four parcels (460.63 acres) are FSC certified and enrolled in VFF, and the remaining twelve parcels (1389.99 acres) are forested lands owned by the College. The certification of the four parcels now enrolled in VFF was a great success in the history of the College's land management, and the resulting inventory and certified timber are useful resources for future generations of students. The

College has the opportunity to further investigate timber certification, as outlined in the section on green certification.

III. Findings and Recommendations

Objective 1. Explore Potential to Integrate Renewable Energy Systems into the Bread Loaf Lands

As we discuss in detail the various opportunities available for renewable energy generation in the Bread Loaf area, we want to make clear that the work conducted for this report is preliminary. We are defining merely the energy potential for the area and suggest that further analysis be contracted out by the College to experts in the biomass, wind, solar, hydro, and geothermal fields for a more detailed examination. Recommendation #69 of the College's Strategic Plan references "a demonstrated commitment to research, test and utilize alternative energy sources." Pursuing this commitment on the Bread Loaf lands could significantly contribute to the effort to reduce the carbon footprint of the College's auxiliary operations.

Biomass

Biomass is going to be used as fuel to reduce the College's dependence on oil and will be used for future heating/cooling of College buildings. This transition away from oil dependence will begin soon as the on-campus biomass plant becomes operational in January of 2009. To fuel this facility, it appears that the majority of the biomass will be harvested in the Champlain Valley and not in the Green Mountains. The College currently has a contract with a forestry company serving as a broker that obtains biomass from a variety of local sources. A set of sustainable practices are being developed by the College for the procurement of wood chips in the near future. Meanwhile, the College is also closely watching a pilot project of willow cultivation to see how such a project could be developed on College lands to provide a sustainable source of biomass (SUNY-ESF, 2006).

It has been proposed that the College could also contract out the task of timber harvesting to local farms. Since willow appears to be best suited for the biomass plant and it does poorly in cold climates and on deprived soils, it is unlikely that this will be a factor in the future of the Bread Loaf lands. With this in mind, there are sources of timber from Bread Loaf that can be used to supplement a small biomass plant, like the 10 kilowatts (KW) example priced below. Timber that has been thinned, salvaged, or chipped can be used to fuel a biomass operation. The demands for wood required to run a large-scale biomass operation, like the Middlebury College campus plant, are beyond the capacity of this Bread Loaf region unless substantial timber harvesting was introduced—this, however, is not a suggested idea or possible outcome for the College's lands. There, however, is the possibility of adding a small-scale biomass operation in one central location to generate electricity for facilities on Bread Load lands. Grass pellets are a potential substitute for wood chips, but a close examination of their costs reveals a current price roughly 4-5 times that of woodchips. A small-scale biomass gas fired system could also be used to provide supplemental heating of buildings or water for the structures that are used year round. For our purposes, we looked into exploring small-scale biomass plants that were designed to generate electricity. They have very short payback periods and can generate between 5 and 100 KW of energy. Below is the sample cost structure for a 10 KW biomass plant (TechLine-Biomass for Small-Scale Heat and Power, 2004).

Sample Cost for 10 KW Small-Scale Biomass Plant

Biomass Plant Costs:	**Estimated Cost ($)**
cost per KW	1,800
10 KW system cost	18,000
Installation etc.	2,700
Estimated Total Costs:	**20,700**

This example only details the costs associated with the construction of a small-scale biomass plant that would be fueled by wood chips supplied by the Bread Loaf lands or beyond depending on the size of the system. It is important to note that these system costs do not include operation costs, such as the manpower to run the system or the cost of harvesting or purchasing biomass. At the present time, a system like this will pay for itself in just over 3 years without factoring in operation or fuel costs. While a payback period of three years is very enticing, we suggest that the College has its experts look into the costs associated with buying fuel and operating a small-scale plant at Bread Loaf in more depth.

Solar

The sun can be used to our advantage to generate power on a renewable and inexhaustible basis. Several different technologies exist to harness electricity through solar power including photovoltaic (PV) and solar thermal technologies. Solar power can also be used to generate heat and energy in other forms than electricity by passive solar techniques which help radiate heat and through the solar heating of water.

- PV panels take in the sun’s energy and convert it to DC current through a fairly simple design.
- Solar thermal electricity generation involves a complex array of mirrors that focus the sun’s energy at a focused spot to create heat. This heat is then transferred to water that is turned to steam and runs an engine to generate electricity.
- Passive solar techniques involve positioning a thermal mass that can absorb sunlight throughout the day and then give off heat at night as temperatures cool.
- Solar water heating uses the sun’s power to heat water that can be used for a building’s hot water supply.

Electricity generating solar thermal power plant designs are intended to be built in places that have high intensities of sunlight and rare cloudy or rainy weather to function optimally. States that provide outstanding locations for the generation of electricity through solar thermal power are Nevada, Arizona, and Florida. As the cost of such plants becomes reduced and the technology for this type of electrical solar power generation are enhanced, it is possible that Vermont could become a more viable spot for a solar thermal power plant. The College has already planned to potentially allow the construction of a beta (or first of its kind, for the region) solar thermal plant on its main campus. This plant would use the solar thermal technology to heat water and provide a boost for the College's steam system that is used to heat College buildings. This technology was first explored by the College up at Bread Loaf as a means of producing electricity, but it was determined that the land area as well as the negative aesthetics of a site would not make a solar thermal electrical plant a feasible option. In our context, PV panels would be a more welcomed small-scale tool and a fitting addition to the Bread Loaf campus in terms of adding renewable energy generation potential.

At the present time, PV panels can be added to virtually any building or set in a field to track the sun and generate power. PV panels would be a well received and appropriate addition to Bread Loaf because they can generate sustained energy for the Bread Loaf buildings during peak energy usage. Goudi Vandal '07 looked at the solar potential for all of the buildings on main campus. A similar project could be done by an intern or for a thesis on the Bread Loaf campus, but would require a Digital Elevation Model with the heights of all the buildings on the Bread Loaf campus.

The entire Bread Loaf campus is on the State Register of Historic Places. This means that it is important to preserve the "historic character" of the campus, but there are not definite restrictions on what can be done to alter the buildings. Act 250 would trigger review of any major renovations planned for Bread Loaf because the property is greater than 10 acres in size. Individual solar panels would probably not require the Act 250 review, but it would have to be taken into consideration (Jen Bleich, pers. comm. 2008). The Franklin Environmental Center at Hillcrest is also listed as a historical building and was recently fitted with solar panels, so such actions at the Bread Loaf campus are definitely possible and highly recommended.

While there may be few issues with the State, there will likely be concern among people who use Bread Loaf on a consistent basis that may think that solar panels change the historic look of the buildings. The majority of the buildings are on the north side of the road, so solar panels placed on the southern roofs would be visible from the road. However, placement of the panels most likely would be successfully achieved if they were located on the southern side of the road so the solar panels would not be noticeable to the majority of the Bread Loaf campus. Out of the 673 Middlebury faculty, staff, and students who responded to the Bread Loaf Opportunity Survey about potential projects for the lands, 58.1% said they were interested in pursuing solar energy.

The Bread Loaf buildings are old and therefore not very efficiently designed. Although installing solar panels will definitely help alleviate electricity costs, it is important to preserve the historic nature of the buildings to the greatest extent possible. Solar panel technology is advancing at lightning speed. As a result, panels are now available that blend in very well to a building's roof. Even so, the costs versus benefits must be weighed in advance of the decision to install solar panels on the roofs.

This rough cost model for 5 KW of solar power is preliminary and does not include reductions in cost for future tax credits or other incentives that are/might be available on a state and national basis at the present time or future.

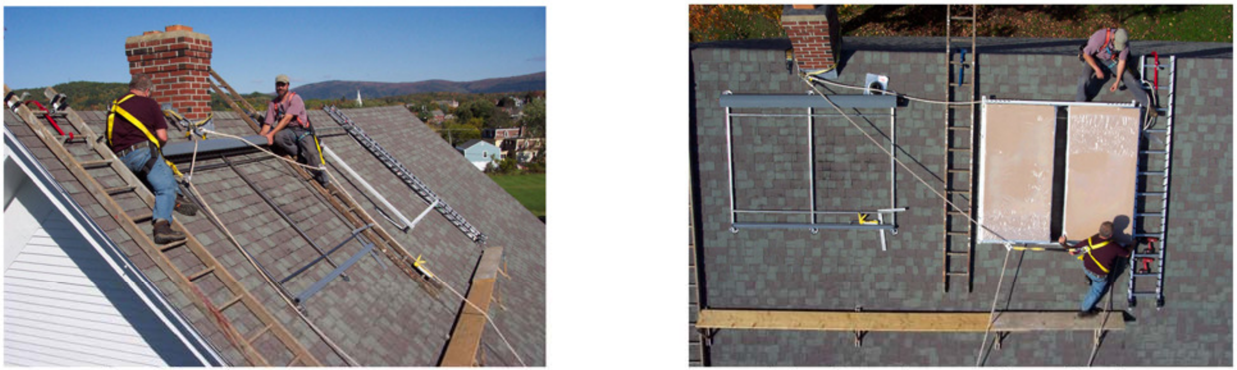
Sample Cost for 5 KW of Solar Photovoltaic Panels

Equipment / Construction Cost	**Estimated Cost ($)**
Panel Cost per Watt	4 to 5
Installation Cost per Watt	3
Panel Cost for 5 KW system	25,000
Installation and other costs for system	15,000
Estimated Total Costs:	**40,000**

As shown above, a 5 KW system is a fairly expensive option. Currently, solar power units in this part of the country are carrying a payback period of approximately 15 to 20 years due to inconsistent sun intensity and the generation of electricity only during light hours. However, solar technology is quickly evolving so payback periods could change in the near future.

Regarding passive solar heating, it would be most pertinent to examine this technology when undergoing renovation or looking at new construction as it requires positioning a thermal mass, such as a cement floor or a wall containing water, which can absorb sunlight throughout the day. This is perhaps the most basic of the systems as it simply involves the absorption of heat into floors and walls, which is then radiated inside when the air temperature falls in the evening.

An additional method of utilizing solar energy is solar water heating. Solar panels were recently installed in College housing at 107 Shannon Street on Middlebury's main campus to heat the house's hot water (Facilities Services Newsletter, October 2008). The Bread Loaf Inn houses the kitchen of the Bread Loaf campus and uses significantly more hot water than the rest of the buildings (Mark Gleason, pers. comm. 2008). Different types of panels were selected for the apartments at 107 Shannon Street to "evaluate which one works best in Vermont" (Facilities Services Newsletter, October 2008). With this base of knowledge already in place, installing solar hot water panels at Bread Loaf, specifically on the Inn, would be a relatively simple way to help alleviate some of the fuel needs of heating this water. This is especially the case in the summer months when the Bread Loaf programs are in full effect.



Installing the mounting system.

The first solar panel is set in place.

Behind the scenes, the solar storage tank is installed.

Figure 5. Installing solar hot water panels at 107 Shannon Street, Facilities Services Newsletter, October 2008

Mark Gleason, Project Manager II in Facilities Services, mentioned a twelve-year construction and renovation plan for the Bread Loaf campus that includes two newly proposed buildings. The construction of these buildings could incorporate any of the above solar options.

Wind

Wind turbines are able to harness energy from the wind and convert it to electricity. The most important factors in the placement of a turbine are mean wind speed and wind speed frequency.

The Department of Energy measures wind power on a scale of 1 to 7 with 1 being the weakest and 7 being the strongest (Table 2). The American Wind Energy Association (AWEA) specifies that sites with at least class 2 may be suitable for small-scale turbines while industrial-scale turbines generally require wind class of 4 or higher (AWEA, FAQ).

The wind data from Associated Weather Services (AWS) TrueWind Solutions has a resolution of 200 m, which is low in terms of examining small areas such as the Bread Loaf parcels. In order to get true wind values at a certain site, the best option would be to install a meteorological tower. However, for coarse information, the AWS TrueWind data, in addition to examining topography, are helpful. According to these data, there is no area that has a wind power class greater than 2 within the Bread Loaf parcels residing in Ripton. In addition, most of these parcels are heavily forested. If any sort of wind potential were to be pursued it would have to be on the level of small-scale residential turbines. Looking into the placement of a small-scale turbine on the parcels in Ripton would be an excellent future project for a thesis or an internship.

Classes of Wind Power Density at 10 m and 50 m				
	10 m (33 feet)		50 m (164 feet)	
Wind Power Class	Wind Power Density (W/m2)	Speed m/s (mph)	Wind Power Density (W/m2)	Speed m/s (mph)
1	<100	<4.4 (9.8)	<200	<5.6 (12.5)
2	100-150	4.4 (9.8)/5.1 (11.5)	200-300	5.6 (12.5)/6.4 (14.3)
3	150-200	5.1 (11.5)/5.6 (12.5)	300-400	6.4 (14.3)/7.0 (15.7)
4	200-250	5.6 (12.5)/6.0 (13.4)	400-500	7.0 (15.7)/7.5 (16.8)
5	250-300	6.0 (13.4)/6.4 (14.3)	500-600	7.5 (16.8)/8.0 (17.9
6	300-400	6.4 (14.3)/7.0 (15.7)	600-800	8.0 (17.9)/8.8 (19.7)
7	>400	>7.0 (15.7)	>800	>8.8 (19.7)

Table 2. Wind Power Density (source: AWEA, FAQ)

The Snow Bowl also shows possible potential for the placement of a wind turbine. Based on the wind data from AWS TrueWind, there is a region on the west side of Worth Mountain with wind class ranging from 3 to 5. The ski trails and the Long Trail's crossing through the Snow Bowl greatly limits the feasible areas to place a wind turbine (Appendix 3), but it is still viable.

Lauren Throop '04 wrote her thesis on the potential for wind energy at Middlebury College's Worth Mountain. After installing a meteorological tower in the fall of 2003 for 6 months and analyzing wind speed data, she concluded that Worth Mountain is a good site for wind development due to its high wind exposure, the fact that it is near an electrical grid, and the fact that the landscape is already impacted. In addition, due to the fact that the Snow Bowl already exists on Worth Mountain, most of the infrastructure required already exists. One of the larger infrastructure changes required would be to extend the electrical grid past the base of the mountain and to the proposed turbine site.

The viewshed of a turbine placed on top of the mountain would be the same viewshed that already exists from the current development. The mean wind speed is approximately 6.39 m/s (Figure 6), which is near the industrial-scale requirements, which means the energy produced by a wind turbine with 19-20 m blades would generate approximately 48-53% of the Snow Bowl's annual electricity consumption (Throop, 2004).

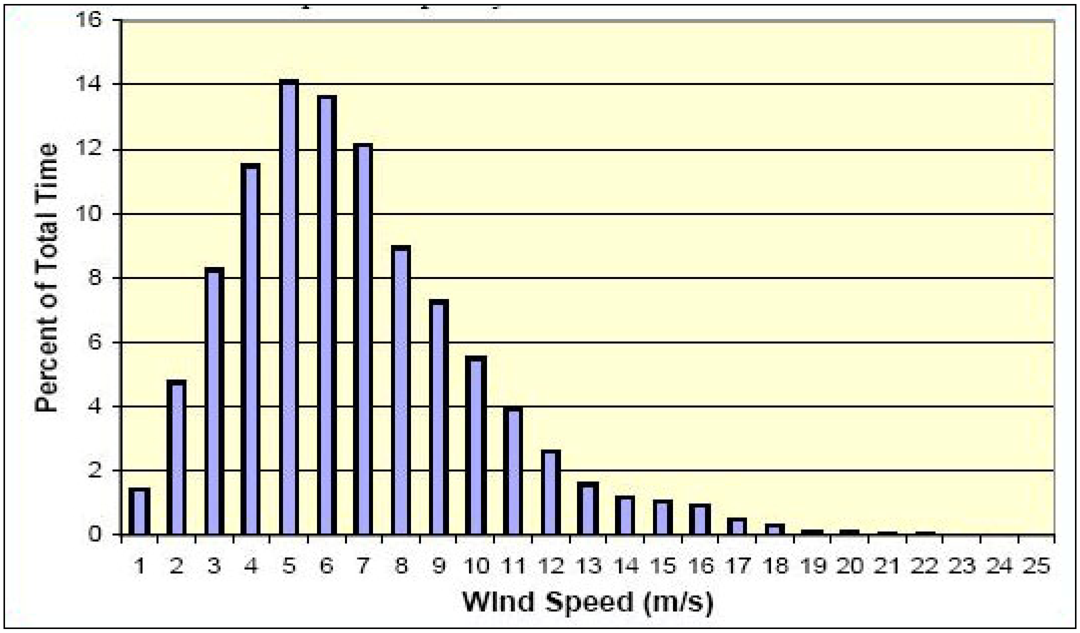


Figure 6. Throop Thesis wind speed data, 2004

For placement of a wind turbine on the Snow Bowl, unlike the other parcels, the town of Hancock would also have to be taken into consideration concerning the viewshed (Appendix 3).

If Middlebury College were to pursue placing a wind turbine on Worth Mountain, Lauren Throop's thesis goes into great depth to explain the benefits and potential problems as well as offering recommendations about what else would need to be looked at before moving ahead with the turbine including:

- Heating the anemometer at 30 m to establish more data
- Continually monitored wind speed data
- Performing a cost-benefit analysis as it relates to the Snow Bowl's electricity costs
- Additional visibility analyses

Heating the anemometer so data can be collected year-round without ice on the blades will provide the most accurate estimate of how much wind energy could be generated at the Snow Bowl. The next step would be to analyze that data in terms of a cost-benefit analysis and see if a wind turbine is viable for the area. In addition, this analysis could include community ownership of, and benefits from, the energy generated.

Micro hydro

Small-scale micro hydro is definitely a possibility in the Bread Loaf vicinity. This electricity generation technology has been proven in the past 70+ years and is very reliable. It is important to note that this will not involve constructing a dam in a river or reducing the flow. The best overall design will have an intake upstream in the river into a submerged, solid piped conduit that will run downstream along the shore (Figure 7). This pipe will provide the suction for a generator and the water will be discharged back into the river (Hydro Turbines, 2007).

To capture energy via hydropower, you must convert excess pressure head in moving water into electrical energy. The electrical energy in kilowatts (KW) that can be harvested is shown by the following relationship:

Power (KW) = 9.8 (factor) x flow (cubic meters/sec) x Pressure (meters) x .7 (assumed efficiency)

Furthermore, to identify a site, the below general criteria must be met.

Assumptions:

1. A free flowing river that has sufficient flow year round
2. Elevation drop of at least 50 feet over a length of 150-200 yards
3. Ability to channelize a portion of the flow in a solid piped conduit of 8-10" in diameter
4. Flow in the conduit should be 1300-1400 gallons per minute (gpm)

System Example:

Install a reverse pump turbine generator that will utilize about 45 to 50 feet of elevation head.

Results:

Net electrical generation at 70% efficiency will produce about 9-10 KW. This is enough to power 9-10 average size (approx 2500 sq ft) homes.

Sample Cost for 10 KW hydro design

Equipment / Construction Cost	**Estimated Cost**
Turbine generator	12,000
Controls package to meet utility requirements and support net metering	25,000
Mechanical, Civil, and Electrical engineering	20,000
Vault to house turbine and controls	10,000
Construction	20,000
Interconnect to the grid - equipment and install by utility	5,000
Piping and valves	10,000
Permitting costs; filings and addressing interrogatories at State and Fed level	15,000
Estimated Total Costs:	**117,000**

With this total cost of $117,000 for a complete micro hydro system installed, the estimated payback period would be less than eight years. This estimate is based off a 10 KW site generating about $15,000 in electricity per year if the retail rate for all-in power is $0.15 per KW hour.

Note: This eight year payback period does not include Net Present Value (NPV) calculations for the change in what money is worth in the future.

Also, this cost setup assumes these three major criteria are met:

1. Stream/river access is close to a road and no major impediments/access for equipment
2. The entity owns the land and right of way on the river.
3. Interconnect point to the grid is close by (within 200 feet).

It is also important to note that these costs could vary substantially—i.e. go up in price drastically if a challenging site is chosen. In this case, the costs in particular for the permitting and construction could increase heavily (Canyon Hydro, 2008).

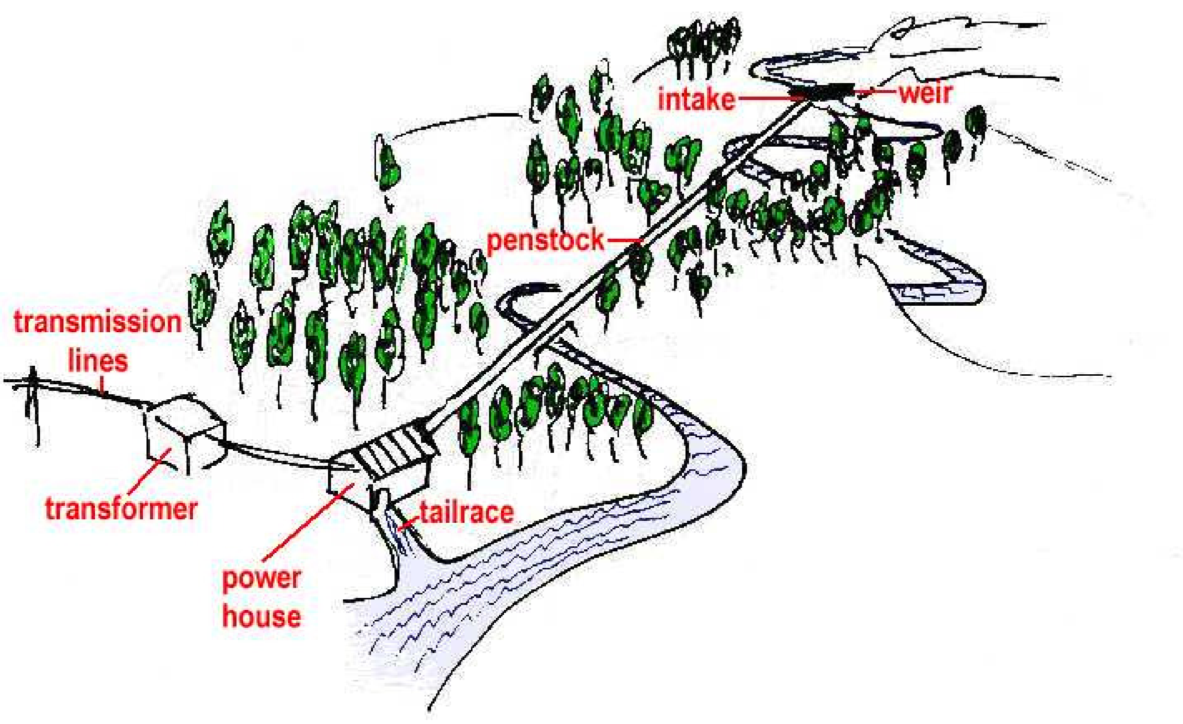


Figure 7. Picture of an example general design for a micro hydro installation.
(Source: Micro Hydro Power)

With the data we have gathered in mind, the next step would be to have the College contract a full hydrological study to be performed on the area. What we have undertaken is just a preliminary analysis of the area to examine the potential and the next step is to have a team of experts analyze the area. This will generate the data that are needed to identify the prime site/s and move along to the next stages of the project if they are appropriate at that present time.

Geothermal

Geothermal power to generate electricity is not currently economically feasible in Vermont due to the depths of which heated rocks are found beneath the surface. The ground in the northeast portion of the United States on average contains low to medium heat that is not warm enough to produce electricity through present technology (Virginia Tech, 2003). However, the ground could play an integral role in creating a heating/cooling source for the Bread Loaf buildings. This technology is called ground source heating and involves basic engineering to regulate a building's temperature around 50-60 degrees during the winter and summer. A system of tubes filled with either water or glycol circulate fluid to almost any type of existing heating/air-conditioning infrastructure (floorboard, hot water, forced air, central air, radiators, etc.) after being cooled or heated by the ground temperature outside. These closed-loop tubes flow underground about five to six feet below the surface where the temperature stays relatively consistent year-round to heat or cool the fluid before being pumped back into the building.

While ground source heating will not enable a house or building to stay at a cozy 70 degrees, it will maintain the temperature to a level that eliminates about 1/2 of the typical heating/cooling costs. Furthermore, this system is virtually carbon neutral—it does not need any fuel to regulate the temperature. The temperature is fully maintained by the ground outside. The only energy needed to run this system is to power a pump to circulate the fluid—a cost that is tiny compared with the cost savings the system provides. A system like this for a building the size of Bicentennial Hall was recently estimated to cost around 250,000 dollars. The payback period for this is relatively short—around 3-8 years at the current time. For a residential size house, a fully installed system typically ranges from 4-8 thousand dollars and the lifespan on systems is typically from 20-40 years (Geothermal Education Office, 2008). Many other options and technologies are available too. For example, at the present time, the Franklin Environmental Center at Hillcrest has a groundwater cooling system in place that helps the building's air conditioning system reduce electricity usage during the hot summer months.

In terms of adding this ground source heating to Bread Loaf, there is significant potential to apply this technology to the existing and/or future buildings. Currently, many of the existing buildings do not contain cooling systems or heating as they are not used for most of the year. However, there are buildings that are used year round that could utilize this technology to reduce dependence on non-renewable energy sources for temperature regulation. It is also important to note that this technology is very clean in nature since almost no electricity is used to heat or cool part of a structure. It is a reliable source of energy and would certainly be a step towards getting Bread Loaf off the grid and closer to a carbon neutral environment.

Summary

All five forms of renewable energy power mentioned—biomass, solar, wind, micro hydro, and geothermal—are viable in the Bread Loaf region from our preliminary research. This largely depends on the amount of capital that the College is willing to invest to support these initiatives as each technology has a different payback period. Regardless, we suggest investigating all of these methods further since reducing the Bread Loaf campus' dependence on grid power is a positive step and one that moves towards further sustainability and carbon neutrality.

Objective 2. Enroll in Timber Certification

Green Certification

There is a very strong possibility of obtaining green certification for all of the plots in Middlebury's Bread Loaf holdings. Green certification is a broad and difficult term to define, but in general, green certification programs are part quality control monitor, part information provider and part marketing agency. Programs such as the Forest Stewardship Council and Vermont Family Forests seek to ensure a certain level of environmentally conscious behavior for timbering and building projects and encourage the development of in depth ecological inventories for lands to be used for human commodities, in addition to providing an attractive marketing label tailored to an increasingly lucrative green commodities market.

Currently, only four of the twenty Bread Loaf plots are fully certified. The Noble Farm Lot, the Upson Lot, the Crystal Brook Lot, and the Mhyre Lot have all been green certified through the Forest Stewardship Council and enrolled in Vermont Family Forests (VFF) because only these four plots are being used by the College for commercial timber harvest at the present time. Although there is no expressed intent to utilize the other plots that make up the Bread Loaf landholdings for timber harvest according to conversations with Steve Weber, the Middlebury College Forester, these other parcels are being managed and maintained in a way that would make them viable for full certification under Vermont Family Forests. The College's land practices at Bread Loaf easily meet the first tenet of the Vermont Family Forests' overall philosophy: well-informed forest steward. The second tenet, sound economic returns from ecological forestry, is currently inapplicable because these lands are not being used for economic returns. However, little effort has been made to branch out and incorporate the land ethic of the surrounding Ripton, Hancock, and Middlebury communities; which is the third main tenet for VFF. In terms of alterations to physical management practices, more extensive reaching out to these communities in order to gain a full understanding of the Bread Loaf lands' place in its surrounding ecological environment and local culture is the only alteration needed. Other than that, the College would need a well-drafted management plan, a demonstrated compliance with VFF access road standards, map of boundaries, a natural communities map, and enrollment fees. Most of the footwork for these documents has already been done, and any further investigation would prove a practical and enriching outlet for student or faculty research.

Pursuing green certification for all of the Bread Loaf lands would serve to bolster the College's standing as a green pioneer and lend legitimacy to its claims as an ecologically sound institution. Furthermore, enrollment in VFF lends a well respected marketing image to any timber to be potentially harvested from the land. There are many green certification programs, but VFF has the benefit of a local focus that would give the College a greater demonstrable claim to active community involvement. According to Dave Brynn of VFF, the College has had nothing but positive experience with Vermont Family Forests in the past. The enrollment of the four lots mentioned above was accomplished with remarkably little turbulence; chiefly because the College already has a firm commitment to sound forest stewardship. It would be beneficial to nurture this already strong relationship with an important player in the local environmental scene. What's more, the development of a comprehensive forest conservation plan for enrollment in VFF would require an in depth assessment and consistent monitoring of the ecological values conferred by the Bread Loaf lands, which would be of much value in establishing the non-monetary benefits provided by the landholdings around Bread Loaf. Ecological services are discussed in greater depth below.

Objective 3. Increase Undergraduate Presence at Bread Loaf Campus

Increasing the undergraduate presence on the Bread Loaf campus has been requested by both members of the academic and athletic faculty. Many members of the College community, including students, also feel that the College lands at Bread Loaf are under-utilized by undergraduates. Furthermore, this objective dovetails with Recommendation #50 of *Knowledge without Boundaries: The Middlebury College Strategic Plan*: increase collaboration across Middlebury programs. Such "collaboration among programs will maximize the resources of each and enhance the cohesiveness of the College as a whole."

Field Camp

One way to increase the undergraduate presence would be to establish a field camp for biological and social research on the Bread Loaf Campus. The Environmental Peak Report and Recommendations (2001) outlined just such a research facility and rustic retreat in its recommendation: *Establish an Environmental Field Station and Rustic Retreat*. The language from that report is found in Appendix 4. Unfortunately, the building was deemed too costly at the time to justify its modest use. However, both senior theses cited in this report in the *Past Ecological Work* section mentioned both the high potential for future research at Bread Loaf and the importance of a permanent structure in aiding the collection of data. With the Senior Work Experience becoming mandatory soon, expanding infrastructure for various types of research at Bread Loaf would be an excellent way to encourage students to conduct valuable work on College lands.

Mark Gleason, Project Manager II at the College, mentioned that three separate buildings, Dragon's Den, Earthworm Manor and Brandy Brook, are currently winterized and might be used to house research activities. He also mentioned that two newly proposed buildings, not yet under construction, would also be winterized and could function in a similar manner.

Earthworm Manor is utilized by the Commons Residential Advisors (CRAs) as a place for free time, and the Dragon's Den is used for time keepers' lodging during winter carnival. Chris Shaw, the Visiting Lecturer in English & American Literature and Associate Director of the Program in Environmental Journalism outlined the Environmental Writers Fellows' use of the buildings thusly, "We keep Dragon's Den as fallback in case we need it (we haven't yet) and stay in Brandy Brook and Earthworm. We eat all our meals in Earthworm, for which Leo brings us some folding chairs and a couple of long tables. It works well for 14-16 people and we've had 20. That's for one week in September. We meet all day in the library upstairs" (C. Shaw, pers. comm.). Lisa Ayers is the person to contact regarding scheduling for these buildings. It is safe to say that their use could be expanded if done so in harmony with current uses.

Carbon Inventory for Sequestration Potential

The process of calculating a carbon inventory at the Bread Loaf lands would provide a valuable opportunity for undergraduate students to engage in service-learning. Students of the natural sciences would be able to learn about concepts such as sampling, tree identification and nutrient cycles from direct experience while simultaneously gathering useful information for the College. In this context, the Bread Loaf lands can serve as a extension of the classroom and engage students in examining the ecological relationships of a local community. Carbon inventory work is an emerging field within contemporary ecology and conservation, and student involvement in this field would help the College maintain its role as a leading institution in academics and sustainability. The results would also help the College learn more about the lands it owns and allow it to continue managing its land to the best of its abilities.

Dr. Marc Lapin, of the Environmental Studies Program, is hopeful that this type of student activity could be incorporated into the Natural Science and the Environment (ENVS 112) curriculum. During the early part of the fall semester and towards the end of the spring semester, field conditions would be appropriate for conducting the inventories. Over the duration of multiple semesters, sampling sites could be distributed throughout the Bread Loaf lands so that over time a more accurate and complete knowledge of the lands could be attained. Given the relative inexperience of many students, hiring Teachers Assistants for two weeks would greatly aid in tree identification and the implementation of the sampling procedure. The results gathered by classes would be subject to student error, but would be useful internally for College decision-making. A student internship or thesis would provide a framework for a more experienced student to gather more accurate data to be thoroughly analyzed.

Objective 4. Value Ecosystem Services

Ecosystem Services

As discussed earlier, enrolling the College lands in Vermont Family Forests would require an in-depth assessment of ecosystem services and values. There are no widely accepted “ecosystem service” measurements as of yet. Most studies have focused on expressing services in terms of benefits (such as flood prevention) and not quantified measurements. That being said, current attempts to establish a universal quantification for ecosystem services have focused on several potentially measurable benefits to be conferred by land: carbon sequestration, flood control, forage production, outdoor recreation, crop pollination, natural community types and water quality and provision. Some of these potential values (forage production, outdoor recreation) would be easier to measure and quantify than others (carbon sequestration, flood control), but at the present time it would be advisable to stick to expressing ecosystem services in terms of rough estimates and abstract values. Quantification of the values and services listed above would be costly and time consuming, and the calculated service values would likely be inexact.

The strongest and most concrete ecosystem service provided by Middlebury’s forested landholdings is the flood control that they provide to the community of Ripton in particular. The forest regeneration that has taken place there has meant a sturdier soil than during its agricultural-use days. Trees hold the soil in place during flood events and further mitigate damage by absorbing some of the water during flood events. In 1927, Vermont experienced a flood in which 85 people died. Certainly a great deal of the damage of the flood was due specifically to the nine inches of rain received in 36 hours, but the treeless hillsides also contributed greatly to the catastrophe. This flood still exists vibrantly in Vermont folklore (D. Mitchell, pers. comm. 2008). After receiving four inches of rain in only a few hours in a flood in the summer of 2008 that damaged bridges from Hancock to Middlebury, some Ripton residents expressed gratitude for the heavily-forested nature of the College lands in lessening damage in their area (W. King and B. Schulz, pers. comm. 2008).

The recreational value of the Bread Loaf lands is well documented and discussed in the introduction and section on community relationships. There is, however, a limited understanding of the natural communities currently using the Bread Loaf Lands as discussed below in the *Ecological Inventory* section. Water quality and provision, crop pollination, forage production, and carbon sequestration have remained largely unexamined for the Bread Loaf lands, but the tasks could be easily facilitated through course work or faculty and student collaborative research. As it stands, the greatest concrete ecological value conferred by the Bread Loaf lands is the runoff retention and flood control that they provide for the Hancock, Middlebury, and especially Ripton communities, as discussed above. This value is understood mostly in the abstract, the extent to which these lands effectively prevent flooding is not known and should be researched further.

Ecological Inventory

The Bread Loaf lands offer an amazing opportunity for ecological research, but have been under-utilized thus far. The Bread Loaf forests represent the ecotone, or transition zone, between northern hardwoods and spruce-fir forests (Lloyd, unpublished data). These lands offer valuable mid- and high-elevation habitat for many Vermont species, including the Bicknell's Thrush (*Catharus bicknelli*), a species of conservation concern (see below) as well as bear mast and deer wintering sites. The area also harbors abundant wetlands – areas deemed important for conservation (Foster et al., 1996; Davis, 1996; MEA 2005). Much more could be determined about the ecology of the area, including in-depth studies rather than general habitat assessments, if the Bread Loaf lands were a focus of long-term studies, which might include several internships or student theses, as happened with the Lake Champlain Bathymetry project or the current gap analysis research being conducted in Battell Woods. One way to facilitate this would be to utilize already existing winterized buildings as field research stations (or incorporate this notion into new building construction).

Spruce (*Picea abies*)-fir (*Abies balsamea*) tree stands are relatively abundant at the Bread Loaf lands and have a particularly high conservation value in Vermont (Lloyd, unpublished data). The National Audubon Society Watchlist, self-described as a "call to action to save species fighting for survival amid a convergence of environmental challenges, including habitat loss, invasive species and global warming," ranked the Bicknell's Thrush, "as the Neotropical migrant of highest conservation priority in the Northeast U.S." (Butcher et al., 2007). While not listed as an endangered species under the Endangered Species Act, this is likely due to it status as "among the least-known breeding birds in North America. Long considered a subspecies of the Gray-cheeked Thrush, it was afforded its own species distinction in 1995" (Butcher et al., 2007). Furthermore, Butcher et al., 2007 note that it is "restricted to high elevation forests," a distinguishing characteristic of the Bread Loaf lands, particularly its spruce-fir stands. Spruce-fir forests have been disappearing on the Eastern Seaboard as a result of acid rain and are increasingly threatened by climate change, so it is important to remember the value of the intact spruce-fir forests in Vermont.

Beech (*Fagus grandifolia*) is another abundant species at Bread Loaf (A. Lloyd, pers. comm., 2008). Beech mast, or beechnuts, play a crucial role in feeding many animal species in autumn, especially bears (Degraaf and Yamaksi, 2001; Hugie, 1982). Beech is also an important species in high-elevation environments in Vermont because no other species produces hard mast in that environment, which mostly consists of spruce and fir trees in addition to beech (Tubbs and Houston, 1990). Furthermore, the chestnut, which produces hard mast similar to that of beech trees, is now regarded as functionally extinct (Wang et al., 2006). Bear populations fell significantly in the 19th century as a result of habitat loss and hunting, but have begun to increase again thanks to forest regeneration (Klyza and Trombulak, 1999; Foster et al., 2002). There is also evidence that deer depend heavily on beech mast (Vermont Fish and Wildlife, 2008). Deer wintering areas minimize energy loss in the deer, and provide essential relief to winter conditions. The boundaries of these areas do not significantly change as long as the appropriate conditions are maintained. Human development in the areas, however, can decrease the number of deer in the area. Since both bear and deer are game animals, and many Vermonters hunt, providing beneficial habitat to these animals allows Middlebury a favorable profile in the community. Furthermore, these large mammals are integral to a complex and healthy ecosystem (N. Jenks-Jay, pers. comm. 2008). Therefore, the ecological importance of the forests that have grown up at Bread Loaf should not be underestimated as they have far-ranging and positive impacts on many different animals.

Carbon Sequestration

The College's knowledge of the Bread Loaf lands would not be complete without an assessment of the amount of carbon they sequester. This information would be an important component of potential carbon offset programs in the future and help the College maintain its status as an environmental leader. Due to various difficulties and inaccuracies in measuring carbon activity both above (Holdaway, 2008; CCAR, 2007) and below (Lloyd, pers. comm. 2008) the ground, it is recommended that the College take an exploratory approach towards assessing carbon sequestration on College lands. As mentioned in our discussion of increasing the undergraduate presence at Bread Loaf, we recommend that within the structure of an Environmental Studies undergraduate course, an internship or a thesis that College students be used to compile carbon inventories. In this way, students will strengthen their field skills while simultaneously gathering data that will help to advance our current knowledge of carbon sequestration. Since carbon sequestration encourages healthy forests, by allowing trees to grow, and thus sequester carbon, we recommend that carbon sequestration be pursued as a management goal since it meshes well with many other goals already pursued, even if its actual value can not be calculated accurately.

Objective 5. Honor and Expand Relationship with Middlebury, Ripton, and Hancock Communities

Community Timber Harvesting

The timber resources of the Bread Loaf lands could be used to provide heating assistance to local community members. Recent trends suggest that fuel prices, which are already high for some residents, may continue to rise in the future. Even with state and federal financial aid, many residents will have a difficult time heating their homes during the long and cold Vermont winters. Harvesting firewood from the Bread Loaf lands for local distribution could help to reduce the financial burdens of its recipients. Our survey furthermore suggests that the Middlebury College community would support such efforts (Appendix 1).

Responding to fuel prices, Middlebury College currently offers grants up to $600 to staff to be used towards heating assistance. The College could expand this program by directly supplying firewood as an alternative to, or in addition to the monetary grant.

Donations of firewood could also be used to support local Ripton residents, which include many College staff and faculty members. This form of local distribution would incur minimal transaction costs and improve relations with the local community. The Ripton Energy Assistance Program (REAP) was recently created to help citizens struggling with fuel prices. The program faces challenges as it must deal with the logistics and costs of harvesting firewood in a safe and ecologically-friendly manner and then distributing it to local homes. Warren King and Barry Schultz, founders of the program, have expressed interest in forming a partnership with the College in order to help overcome some of the difficulties they face. One scheme for the potential partnership would be that when the College is harvesting timber for its own purposes, it earmark a certain amount of surplus or low quality timber for the local community and deliver it to a REAP location. REAP organizers could then process and distribute the timber.

Sugaring

The Bread Loaf lands contain several sugar bushes that could be used for maple syrup production. The process of sugaring, however, is complex and time consuming. Expertise and dedication are required in order to yield a successful final product. Members of the Middlebury community expressed interest in sugaring the survey we conducted (Appendix 1) by indicating strong acceptance of sugaring on College land and moderate interest in engaging in sugaring projects. The process, however, is likely too demanding to coordinate with a student's schedule. A partnership with a local sugaring operation would likely be the best option for sugaring on the College lands. This would take much of the responsibilities associated with sugaring off of the College while still maintaining community involvement.

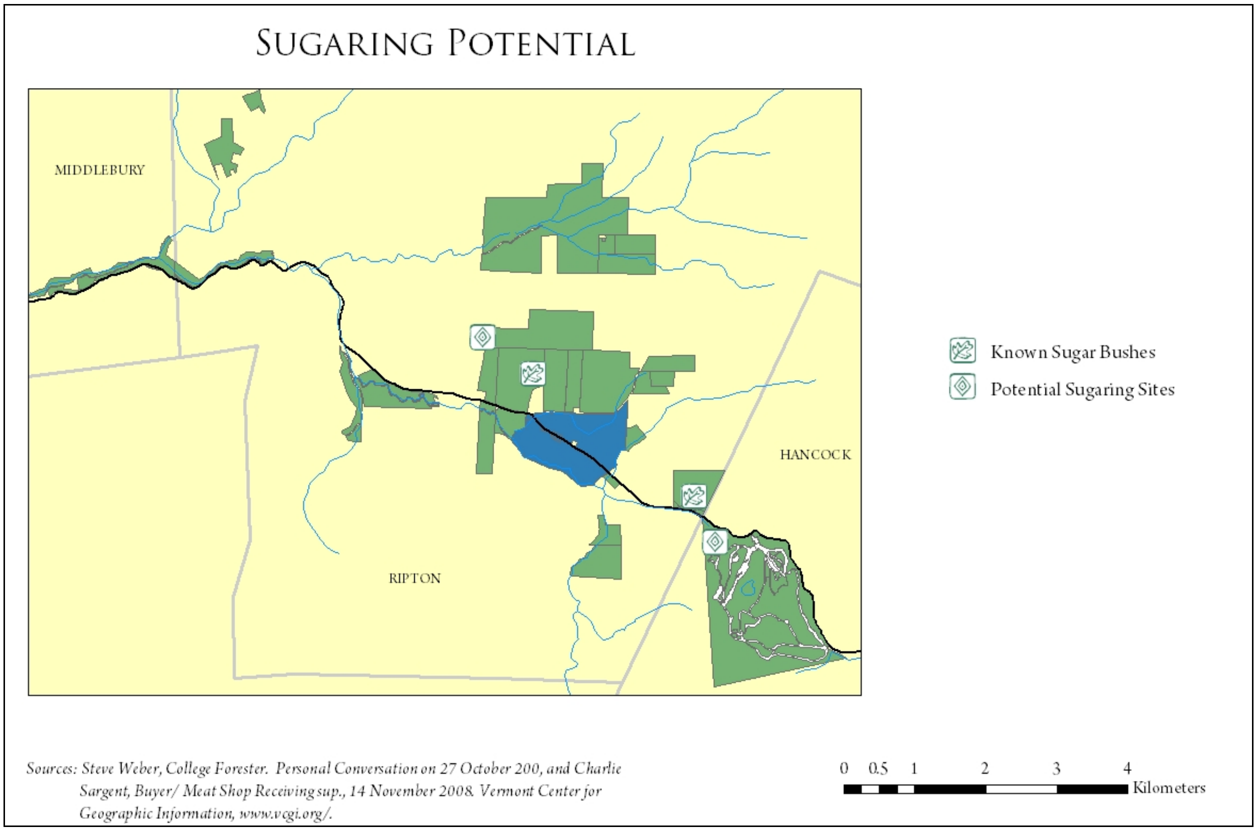
There is a great deal of interest in sugaring in Vermont right now, as the spring of 2008 provided a bad year for sugarers north of Addison County and many sugarers are unclear how global climate change will affect their crop. Low supply and rising fuel costs have created very high prices for syrup in the fall of 2008 and a locally operated sugarbush would help offset some of those costs.

Local sugarer, and Buyer/Meat Shop Receiving Supplier for Middlebury College Dining Services, Charlie Sargent suggested that the College might be able to lease trees for local sugarers to tap. He mentioned that the U.S. Forest Service (USFS), primary land owner in Ripton, has a long history of leasing taps in the area and that taps usually lease for approximately 30 cents per tap. College syrup could be utilized in many ways, including:

1) To supplement some College syrup use by the Dining Services (approximately 40 gallons per weekend, according to Mr. Sargent)

2) To bottle and brand in pint-size containers to sell the bookstore, clearing an estimated $100 per gallon, according to Mr. Sargent, who emphasized the profitability of selling syrup in small containers
3) Pint containers also have potential to be gifts from the College to Alumni and Donors
4) Similar to REAP, College syrup could be donated to Addison County residents who could not otherwise afford syrup
5) As an educational and community integration tool for students interested in exploring the sugaring process, especially continuing in the College's research with Amy Trubek on the notion of *terroir* (taste of place) in maple syrup.
6) The firewood program, outlined above, could be extended to College sugaring operations, by utilizing the College's firewood to run evaporators for College boiling

One caveat of leasing trees would be the extraction agreement. The College would have to outline whether or not taps (and/or tubing) could stay up year-round, where taps (and/or tubing) could be located, how they could be accessed (on vehicle or foot). Mr. Sargent identified the stretch of trees to the skier's left of the Ross trail at the Snow Bowl and lands around the Robert Frost cabin as areas with high sugaring potential, using tubing collection methods that would have minimal impact on the surrounding area (Figure 8).



Sources: Steve Weber, College Forester. Personal Conversation on 27 October 200, and Charlie Sargent, Buyer/ Meat Shop Receiving sup., 14 November 2008. Vermont Center for Geographic Information, www.vcgi.org/.

Figure 8. Sugaring Potential

Recreation

The importance of the recreational opportunities at Bread Loaf should not be underestimated. As discussed earlier in this report, the Spirit in Nature, cross-country skiing and alpine skiing trails and hunting are perhaps the most obvious ways people interact with the Bread Loaf lands. The facilities serve as community hubs and serve to maintain and grow social networks.

The results of the survey we conducted shed more light on the importance of the Bread Loaf lands to the local community. In total, 692 people within the Middlebury College community responded to the Bread Loaf Survey. Nearly 88% of respondents indicated having used the land in some way with hiking, cross country skiing and alpine skiing being the predominant activities. A number of respondents also indicated snowshoeing, running and enjoying the scenic beauty of the lands as uses (See Appedix 1 for the full list of uses). Of people who do use the land, most use the lands several times a year though 30% of respondents use the land more than once a month. Winter and fall seem to be the most popular times of the year for people to visit the lands, most likely due to the opportunities to engage in winter sports or enjoy the foliage respectively.

Respondents were largely appreciative of the opportunity to recreate on and enjoy the beauty of the Bread Loaf lands. Community members expressed strong connections to the land and were interested in maintaining the recreational opportunities and rural character of the land (See Appendix 1 for select feedback from survey respondents).

IV. Unique Features

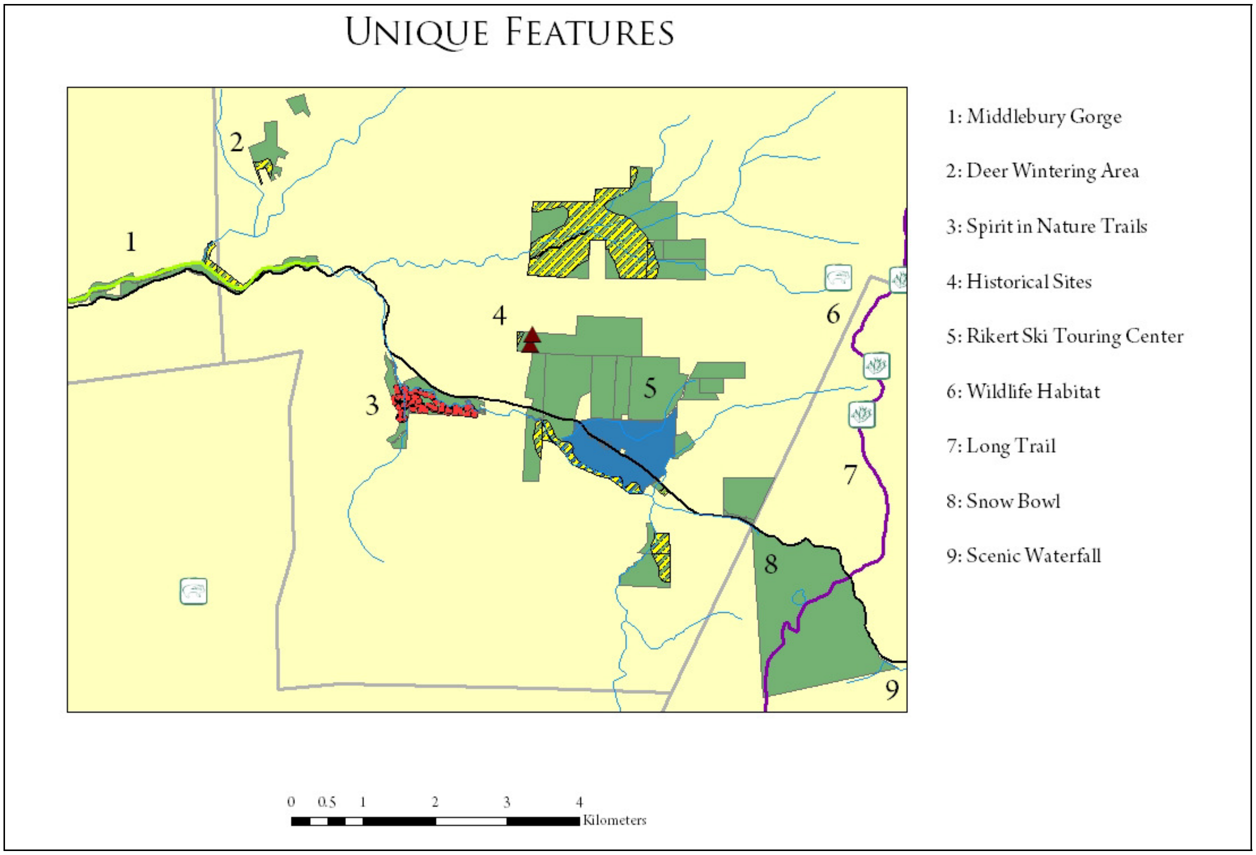


Figure 9. Unique Features

Some of these considerations have already been mentioned, but we feel that their unique nature merits special attention; these features should especially be taken into account when making land use decisions (Figure 9).

Middlebury Gorge and Scenic Waterfall

The gorge, as mentioned above, is an area of unmatched natural beauty. Hiking, kayaking, fishing, and swimming in this area are all significantly enhanced by this natural beauty and are all one of a kind experiences. This enhanced experience is due in part to the sense of mystery and the untouched nature of the area.

Given the difficulty of access into the gorge, there is little else for which it could be used. One possibility could be the generation of hydroelectric power. The feasibility of this should be investigated, and the fact that such power generation would significantly alter such a unique natural area should be taken into consideration. It is our hypothesis that even if hydro power is at all feasible in the area, the power generated would be negligible and the costs of altering such a unique area would far outweigh the benefits offered by such a project.

If this is truly the case, the College might seriously consider enacting some sort of measure that would protect this area in perpetuity. While the language in Battell's will already ensures continued protection, the College has the opportunity to protect a one of a kind resource in its wild state and garner positive publicity, as well as furthering its reputation as an environmental leader with a commitment to stewardship.

The case of the Middlebury Gorge is similar to that of the scenic waterfall in Hancock along Route 125. The College should ascertain whether or not that waterfall has any value other than scenic, and should make a decision on whether or not to conserve the area according to those findings.

Deer Wintering Areas

In addition to the considerations mentioned below in the section on wildlife habitat, the College should carefully consider its efforts to sell the MMMF Lot, given the presence of deer wintering areas in the southwest corner of that lot. College staff have suggested that the lot would be fit for a one house development (Corbin, pers. comm. 2008). If this is the case, the College should act on its commitment to sustainable development (Planning Steering Committee and President's Staff, 2006) and ensure that any development on that land steers clear of the wintering areas.

Spirit in Nature Trails

As discussed in the section on recreation, the Spirit in Nature trails represent a response to environmental degradation that engages many different religious communities and strives to foster a religious community land ethic. This model has been replicated a number of times in New England and should be maintained as an example. In addition, the organization sustains close ties with the College community, and represents an opportunity for students to engage in the local community.

Historical Sites

The Robert Frost cabin and the Homer Noble Farms are two historical sites that are already well conserved by the College. The entire area was at one time covered with farms and stone walls, and remnants of these relics still remain (Hotte, pers. comm. 2008). A fruitful student project could involve an inventory of these relics. Given such an inventory, the College could then decide which of these historical areas to conserve.

Rikert Ski Touring Center and Middlebury College Snow Bowl

As mentioned in the current use section, Rikert and the Snow Bowl serve as community hubs and are the premier winter sports areas in the region. The College should maintain these areas as such. Students with an economic focus could perhaps conduct research on how to make these more efficient businesses, but they serve as an important link between the community and the College.

Wildlife Habitat

As outlined in the section entitled "Ecological Inventory," the College landholdings are comprised of important wildlife habitat, and serve to connect the other forested lands in the area. The lands should be managed to continue serving as habitat not only to maintain the ecological health of the region, but also to serve as an outdoor laboratory allowing future students to study the importance of these species.

Long Trail

The Green Mountain Club maintains and manages the Long Trail, as discussed in the recreation segment of the section on current use. It has long been their mission to ensure the connectivity and future of that trail by acquiring rights for the public to use the trail in perpetuity (Rose, pers. comm. 2008). Middlebury College is one of the few land holders that has not ensured public rights in perpetuity- they grant a license agreement to the Club on a five year basis. This system produces anxiety within the Club. While the renewal of that license is almost always guaranteed, the Club would be much more comfortable were there an easement donated. This would enable them to dedicate more resources to the maintenance of the Long Trail on College Lands, and it would create positive publicity for the College.

However, the language in Battell's Last Will (1913) explicitly states that the trustees of the College should have discretionary power over the admittance of Vermont citizens in perpetuity. To grant such an easement would be to renege on a legally binding document.

We would like to propose a potential solution to this conundrum. If the College were to potentially pass a trustee resolution granting use until deemed unfeasible to do so, it could potentially alleviate some of the anxiety experienced every five years but still maintain discretionary power over the lands mandated by law. Such language could reflect the language of the will. The College could allow public access to the area in perpetuity unless the conditions under which it is not reasonable to do so force the Board of Trustees to prohibit such access. This solution represents a compromise on the part the club, in that it will lose the short term guarantee of five years. However, it will not have to go through the licensing process every five years. Club and College officials should meet to discuss the legal mechanisms through which such an agreement could take place.

A somewhat less collaborative solution would involve building a new trail that circumvents the College lands, though the College could also help with this endeavor financially.

V. Conclusions and Further Research

As this report has illustrated, the College-owned lands in Ripton, Hancock and East Middlebury represent myriad opportunities for Middlebury to further its educational mission and its environmental leadership. While the College has historically been a responsible steward, especially in terms of community involvement in the form of recreation, the College can expand its stewardship goals in a number of areas. The lands around Bread Loaf afford options for renewable energy which could be useful in helping the College meet its goal of lowering the carbon footprint of auxiliary operations. While further research is needed, the initial assessments of many renewable technologies are reasons for optimism. Further work with VFF on green timber certification will not only improve the College's reputation as an environmental steward, but it is also a good first step in better understanding forest structure and ecological services. As part of the Northern Green Mountains natural community, the lands afford many services ranging from flood control to wildlife habitat. There is currently only a vague understanding of these services, and student and faculty research could expand that knowledge base. The lands are currently underutilized as an educational resource, and there is significant faculty support for increasing the undergraduate presence on the Bread Loaf lands. Though the College already engages the community through allowing recreation on its lands and in other ways, community outreach could be extended through strengthening the College's and Ripton's heating assistance program and investigating a community sugaring program.

These are surely not the only stewardship goals worth pursuing on the College lands. As mentioned, this report has only skimmed the surface of the opportunities afforded by these lands. We hope that the Land Stewardship Advisory Group will move forward on the recommendations outlined in this report and will consider new recommendations when they arise. Furthermore, we hope that the Group serves as a progressive forum on how the College should steward its lands. During the course of this project we learned that there are many individuals at the College with vested interest in the uses of the lands at Bread Loaf. While the Board of Trustees and the College staff will continue to be responsible for decision making on these lands, we hope that the Land Stewardship Advisory Group and others will set out to encourage projects that help the College community better understand the opportunities available on these lands and pursue stewardship goals that reflect the College's greater mission. The Group might take a first step to furthering stewardship of these lands by undertaking some or all of the inventories recommended in Appendix 5.

An attitude of opportunity pervades the College community when discussing the forested lands at and around Bread Loaf. They represent an opportunity to further the College's educational goals, goals related to being a responsible community member, and the goal of furthering the College's environmental leadership. If we synthesize different interests and manage the landholdings in an environmentally and fiscally responsible manner, the Bread Loaf lands play a large part in furthering the College's tradition of environmental leadership.

VI. Appendices

Appendix 1: Bread Loaf Opportunity Survey

Methods

The following survey was emailed to members of the Middlebury College community, including students, faculty and staff. The survey asked about what activities they currently engage in and the frequency of use. The survey also gathered opinions on what sorts of development and resource extraction the College should engage in. Support for alternative energy development such as wind and hydrologic power was addressed. The survey attempts to predict local support for a partnership with REAP. It also seeks to measure support for the development of more economically motivated infrastructure such as cell phone tower development and timber and maple sugar extraction. With an understanding of the community's vision for the land, the College can effectively manage the land with the support of local communities.

The Bread Loaf Opportunity Survey

Hello!
We are a group of Middlebury College Environmental Studies seniors from the Environmental Studies Seminar researching the current and possible future uses of the College's land at Bread Loaf. This area includes the Bread Loaf campus, the Rikert Touring Center, the Snow Bowl, the Spirit of Nature trails and other lands (see map). We are surveying members of the Middlebury College and Ripton communities in order to understand the use of and attitudes towards these valuable assets. Your responses to the questions below will provide valuable input to our project. This should take no more than 5 minutes of your time!

Thanks again for your participation!

1) How do you use the College's land indicated on the map? (Please check all that apply)
    I don't use the land
    Research/ Academic Purposes
    Hiking
    Cross-Country Skiing
    Alpine Skiing
    Wildlife Viewing
    Hunting
    Other (__________________)

How many times, on average, do you visit these College lands a year?
    Once a year
    Several times a year
    Once a month
    Several times a month
    Once a week
    More than once a week

In which seasons do you visit Bread Loaf area lands the most? (Please check all that apply)
    Fall
    Winter
    Spring
    Summer

Which of the follow do you consider to be appropriate activities to engage in at these College lands? (Please check all that apply)

Research/ Academic Purposes
Hiking
Cross-Country Skiing
Alpine Skiing
Wildlife Viewing
Timber Harvesting
Sugaring
Hunting
Other (__________________)

In your opinion, should the College expand facilities for any of the following activities? (Please check all that apply)

Facilities are adequate as they are
Research/Academic Purposes
Hiking
Cross-Country Skiing
Alpine Skiing
Wildlife Viewing
Hunting
Other (__________________)

What types of projects would you like to see the College engage in at these lands? (Please check all that apply)

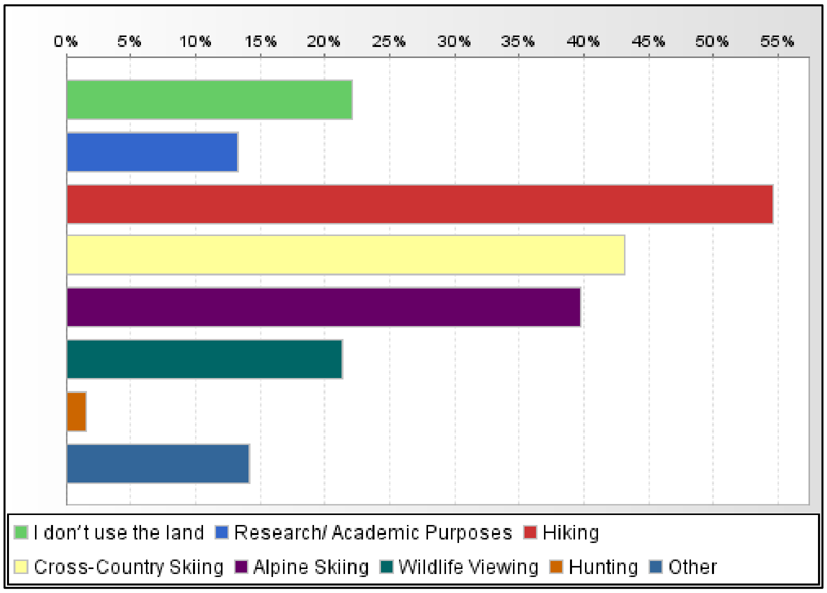
Maintain status quo
Wind power development
Solar power development
Real-estate development
Cell phone tower construction
Sugaring
Firewood extraction to benefit College and/or local community members
Carbon Sequestration
Timber Certification
Other (__________________)

Is there anything you would like to add about these College lands?

Findings

Current Use

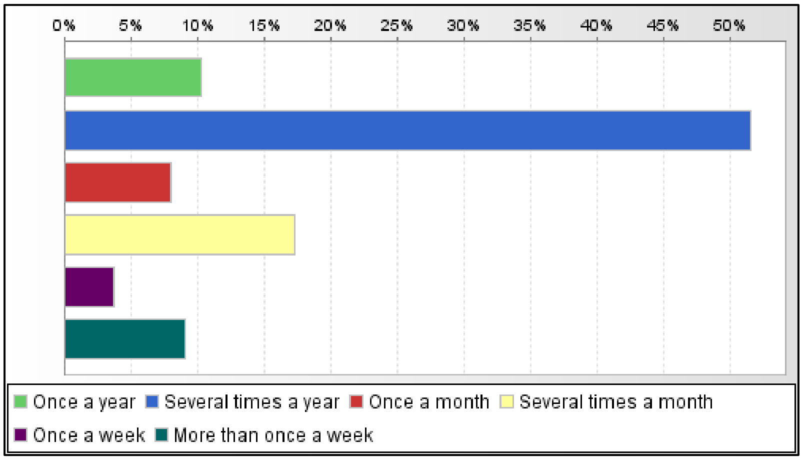
Question 1. How do you use the College's land indicated on the map?



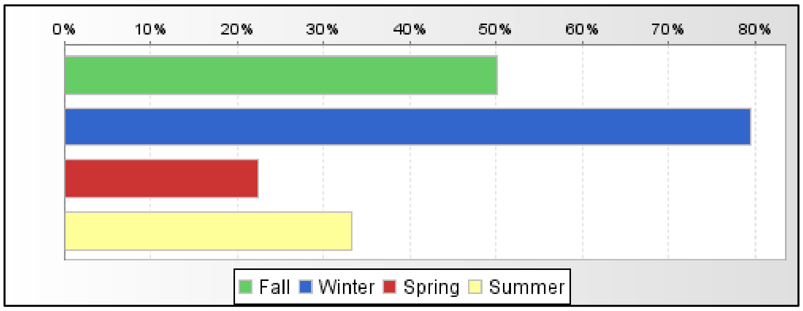
Respondents indicated the following uses of the College lands:

Alpine Skiing, Biking, Birding, Camping, Canoeing, Classes, Cross-Country Skiing, Dog-walking, Drawing/Sketching, Elementary school student visits, Enjoying a beautiful view (Especially the foliage in the fall), Event watching, Fishing, Flying kites, Forest management activities, Hiking, Hunting, Meetings, Mountain biking, Orientation trips (MOO/ MiddView), Painting, Performances, Photography, Picnicking, Relaxation, Research/ Academic Purposes, Running, Sledding, Snowboarding, Snowmobiling, Snowshoeing, Stargazing, Swimming, Trail running, Wandering, Wildlife Viewing, Writing Music

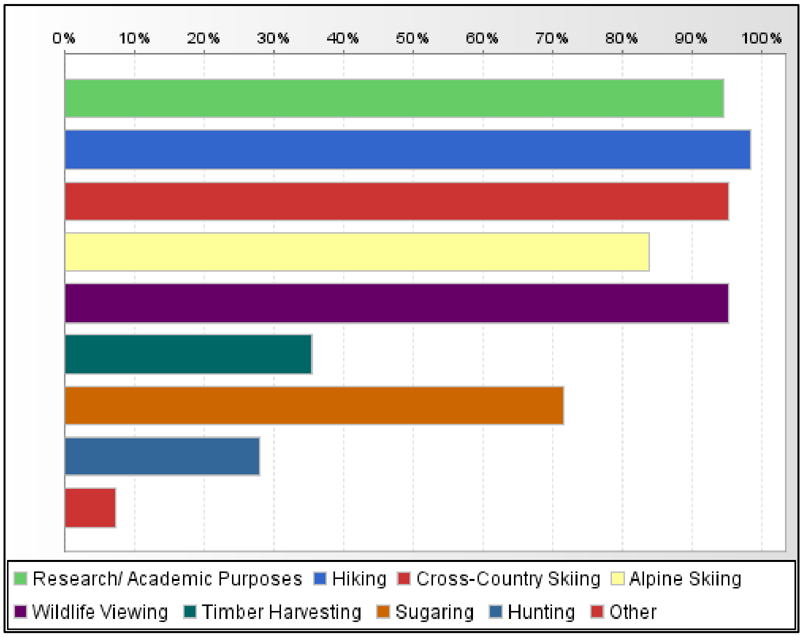
Question 2. How many times, on average, do you visit these College lands a year?



Question 3. In which seasons do you visit Bread Loaf area lands the most?

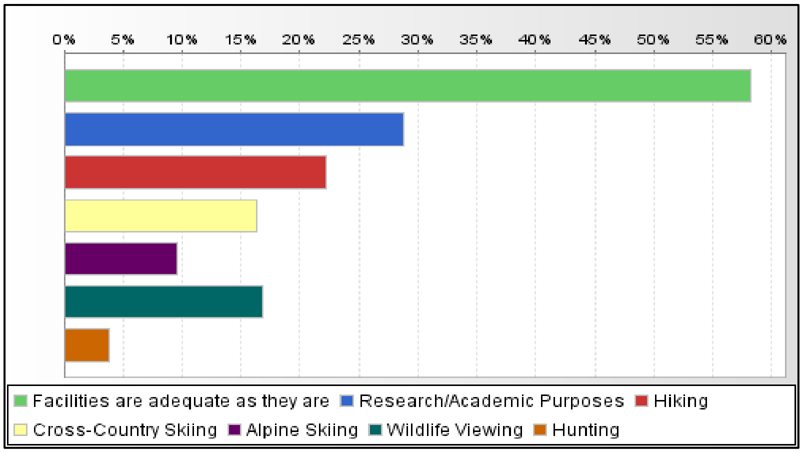


Question 4. Which of the follow do you consider to be appropriate activities to engage in at these College lands?

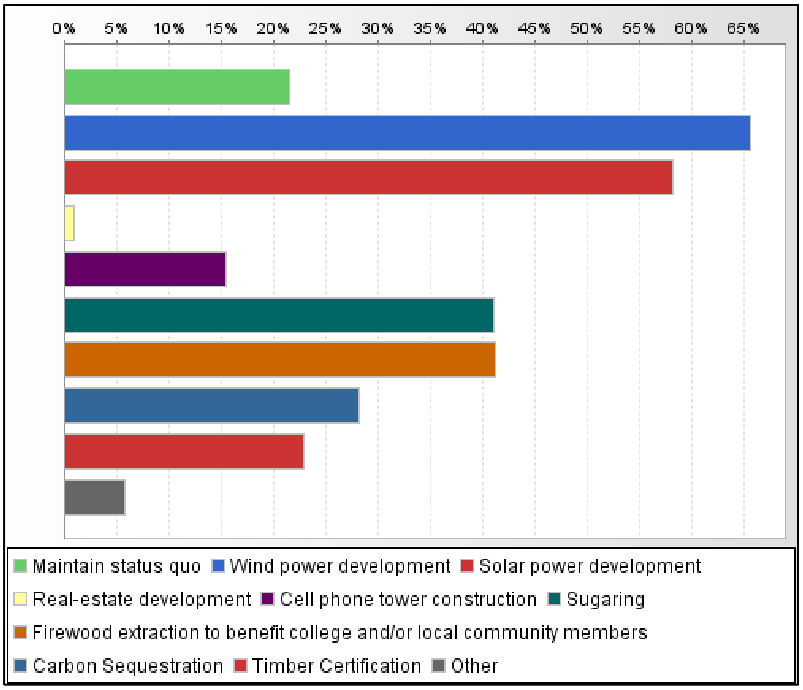


*Some respondents indicated their support for timber harvesting only if it was done in a limited and responsible manner.

Question 5. In your opinion, should the College expand facilities for any of the following activities?



Question 6. What types of projects would you like to see the College engage in at these lands?



Attitudes

Respondent to the survey indicated strong support for wind and solar power development and moderate support for sugaring and firewood extraction to benefit College or local community members. Respondents were less supportive of timber certification and carbon sequestration than other projects, but this may be due to a lack of familiarity with these concepts. Several respondents indicated that they did not understand what these projects entailed.

Members of the Middlebury College community expressed the following opinions towards the College's Bread Loaf lands in our survey:

"They're precious, and among a very few things that make Middlebury such a special place."

"I love the lands!"

"I appreciate that the college currently shares the land so generously with the community."

"They are an amazing resource and the College does an excellent job preserving them."

"Keep them as natural as possible."

"They are beautiful and definitely worth preserving for future generations."

"Any new uses… should be thoroughly researched for impacts on all the species who live in and use the lands."

"Please do everything to protect them and keep them in use in appropriate ways for the college and local community."

"This is a beautiful part of Middlebury College that few take advantage of."

"[The College] should look at setting an example of using renewable resources in a responsible way."

"The affordable access to skiing and snowboarding is a great employee benefit!"

"They are one of the ways that Middlebury distinguishes itself from other colleges."

"An underutilized outdoor classroom."

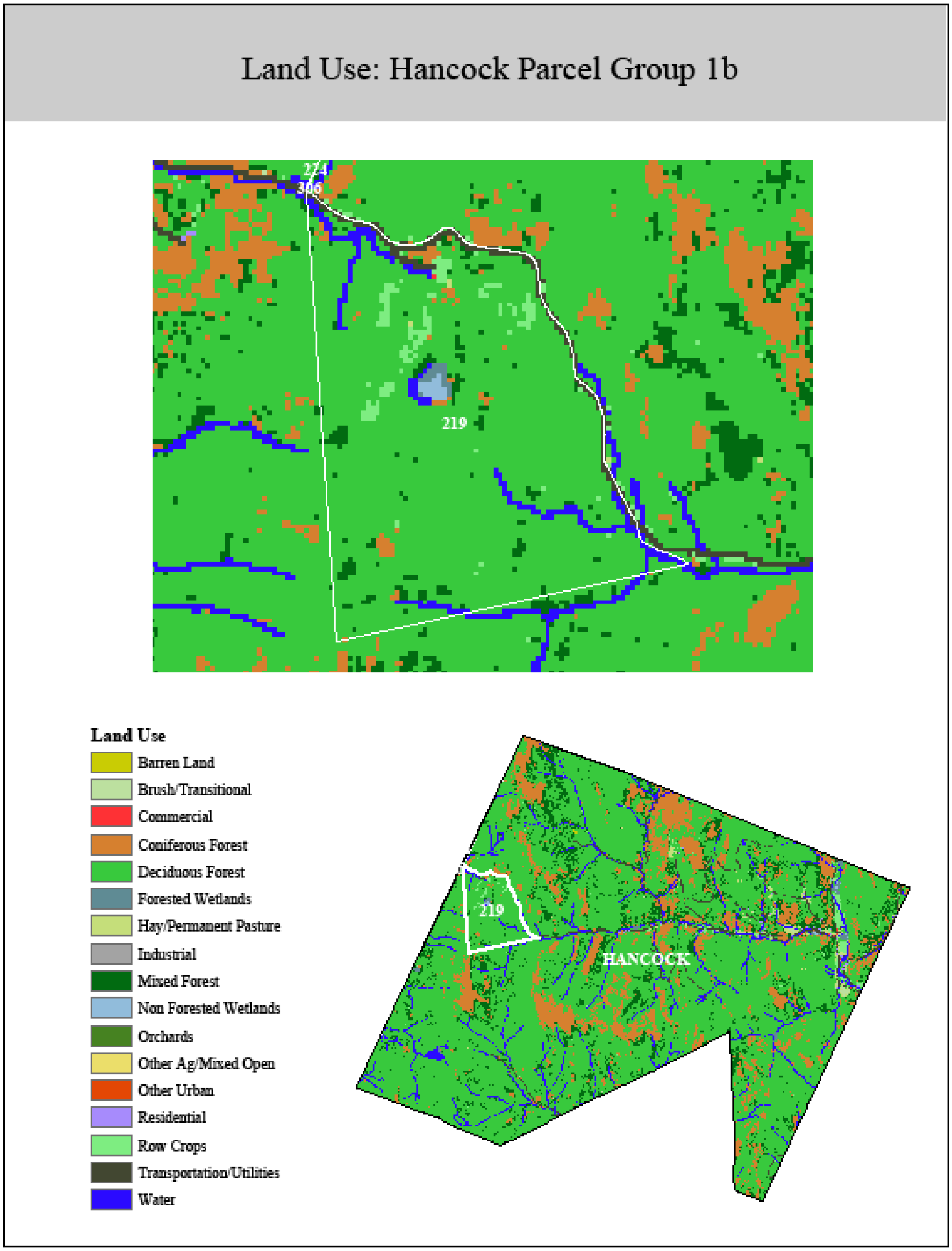
"They are a big part of my and my family's life."

"Future management should take a dynamic approach that allows people to enjoy it through recreation, but also gain economic benefits in a sustainable, local way."

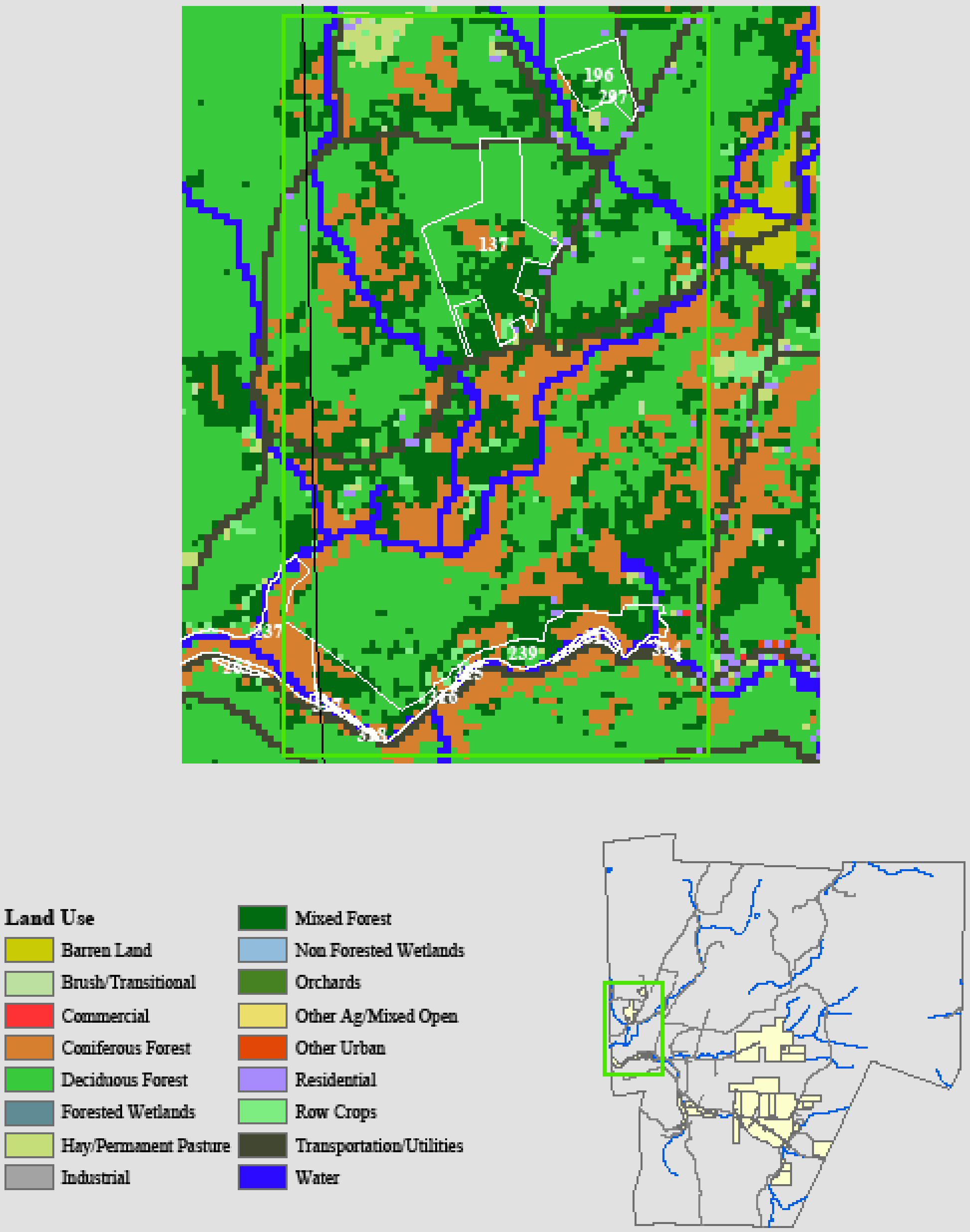
"This land is a vital part of the College's identity: It should be celebrated and preserved, including it's history (early farms, Joseph Battell), diversity (Bread Loaf campus architecture, Lake Pleiad), and setting (mountain towns of Ripton and Hancock, Green Mountain National Forest, Moosalamoo)."

Appendix 2: Current Land Use Maps

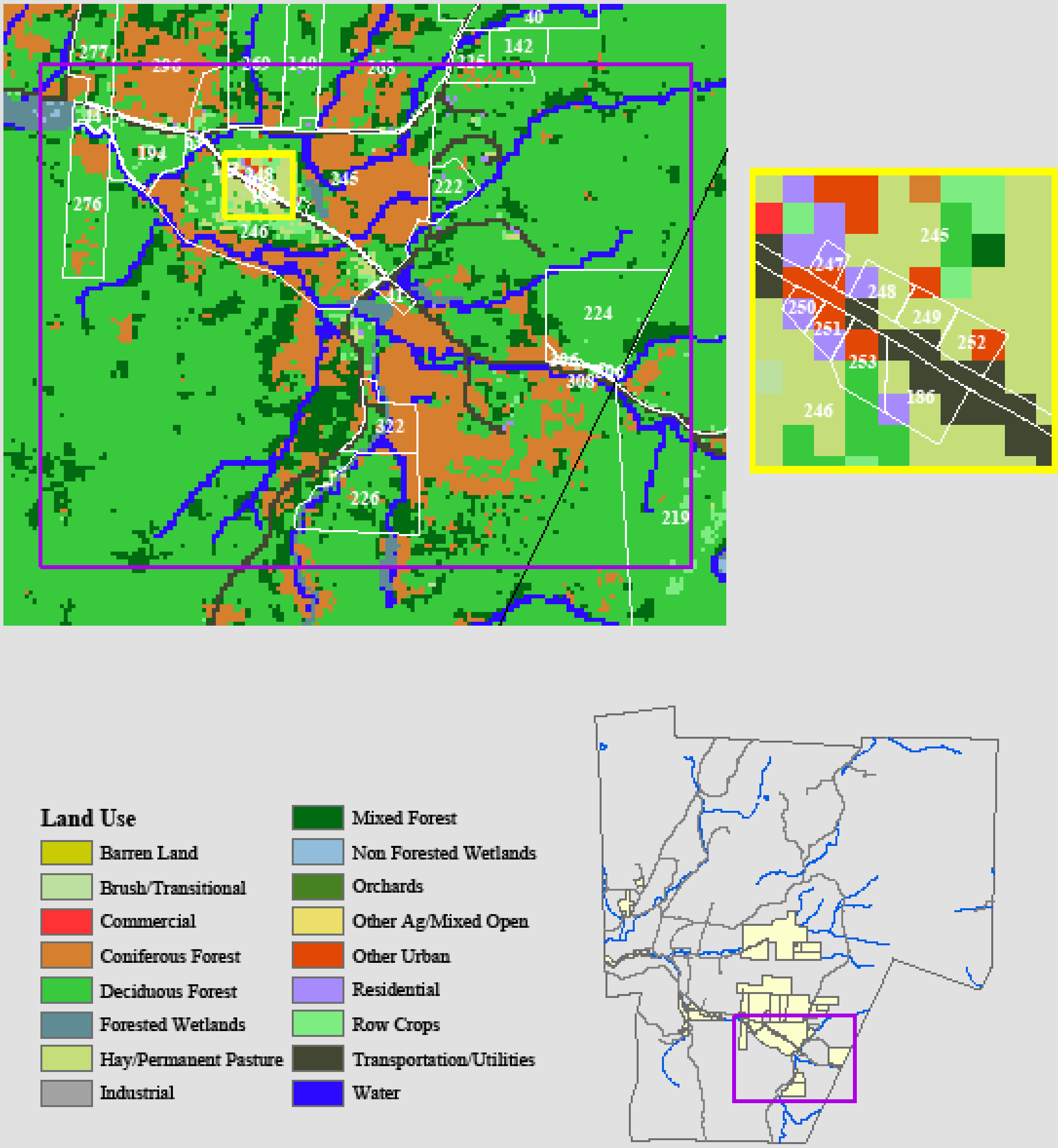
The following maps were put together by Chris Eberly, Kate Merritt, and Andy Peters.



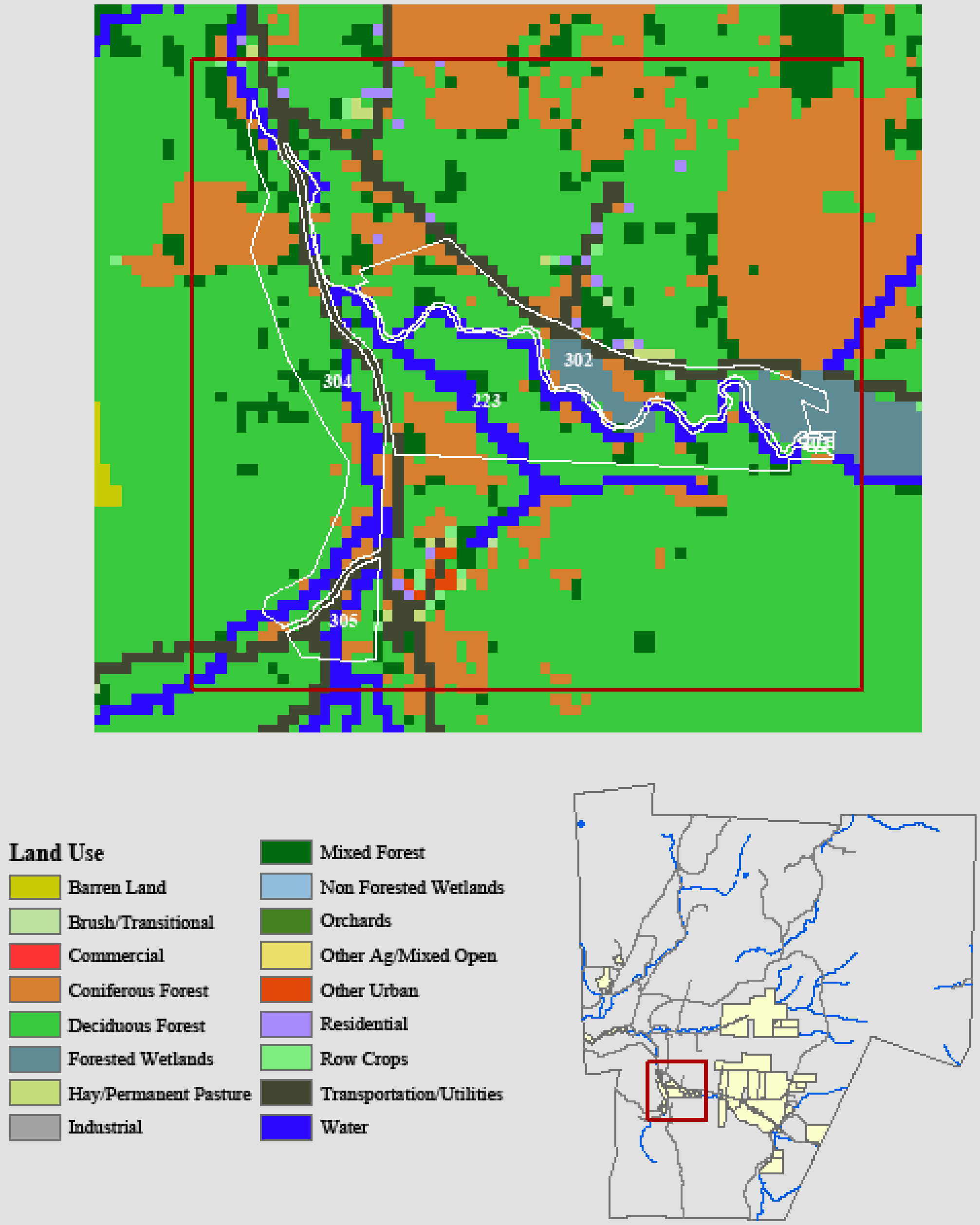
Land Use: Ripton Parcel Group 2c



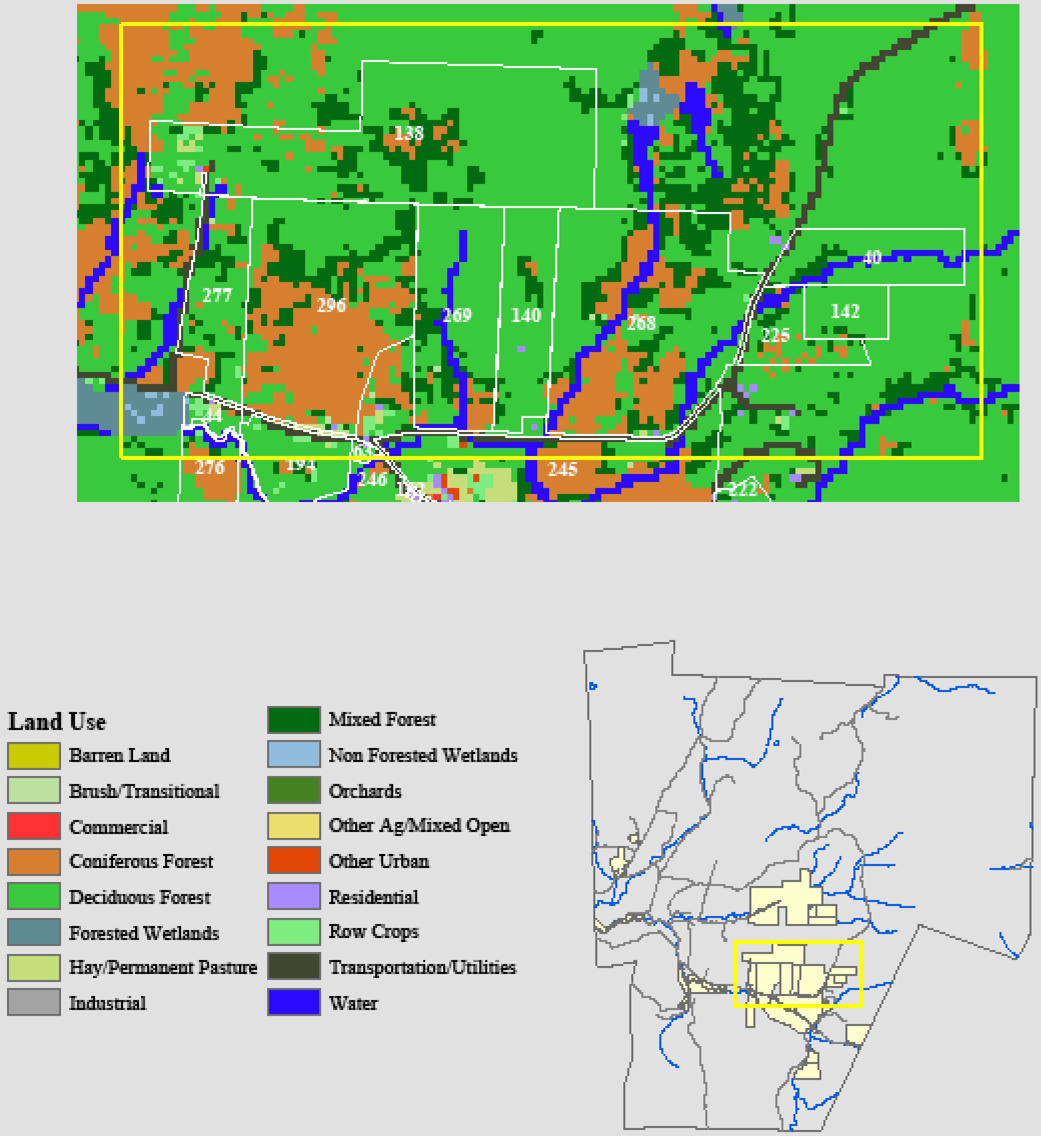
Land Use: Ripton Parcel Group 3c



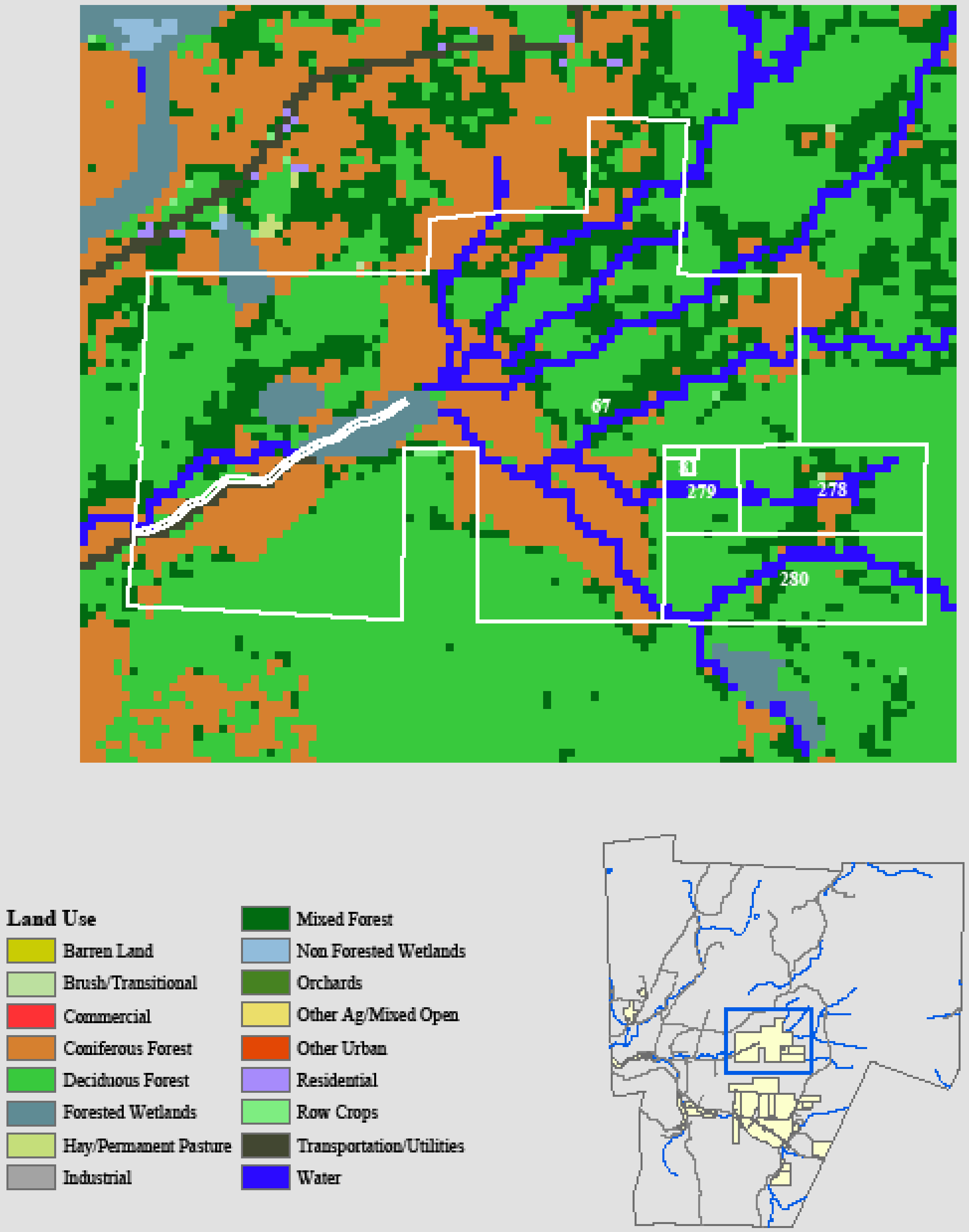
Land Use: Ripton Parcel Group 4c



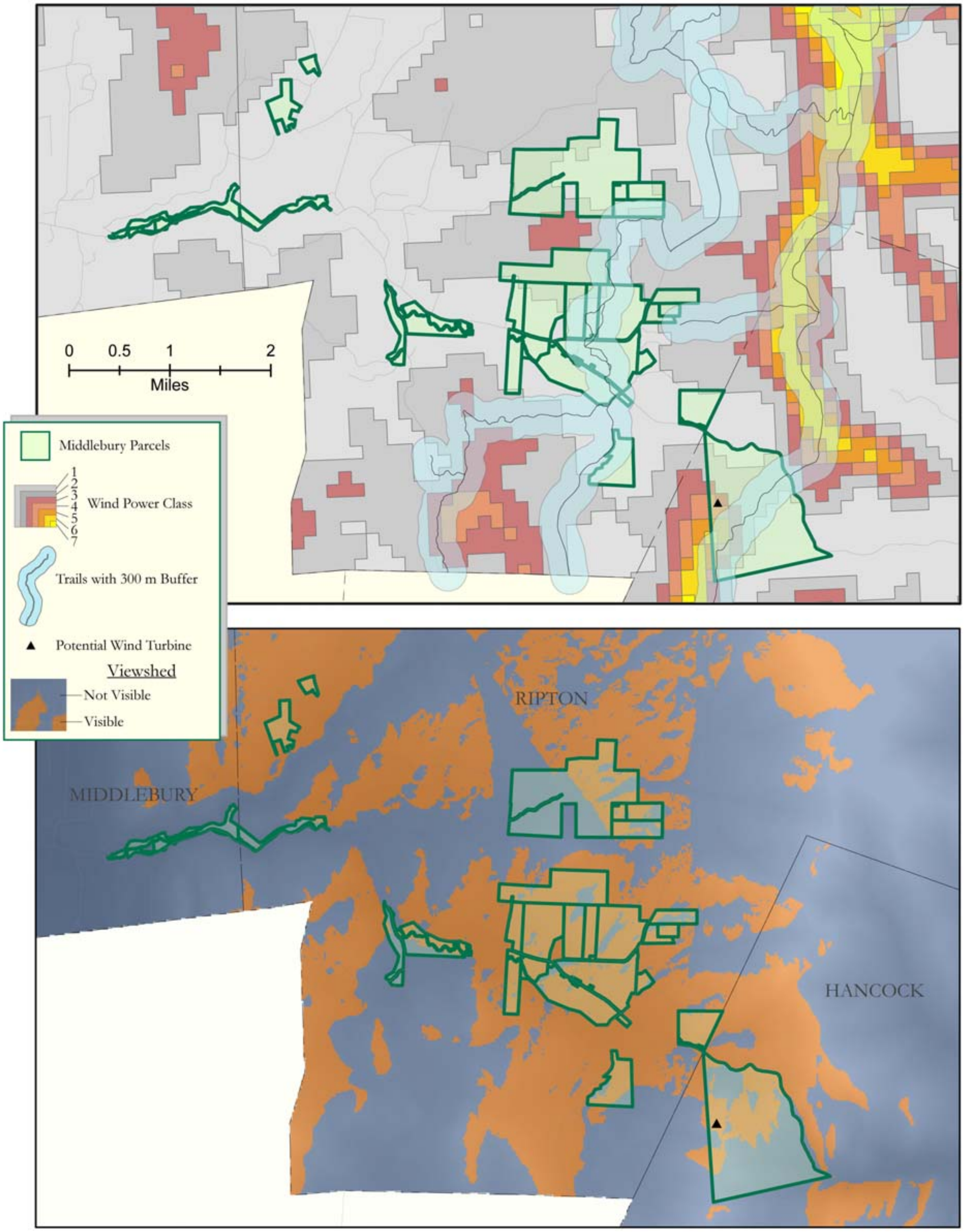
Land Use: Ripton Parcel Group 5c



Land Use: Ripton Parcel Group 1c



Appendix 3: Wind Power Potential



Appendix 4: An Excerpt from Environmental Peak Report and Recommendations 2001: A Vision for the Future

August 2001

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Produced by the Environmental Peak Task Force 2000-2001
Nan Jenks-Jay - chairperson, Jim Larrabee - administration liaison, Chris Klyza, Kathy Morse, Amy Seif, Sallie Sheldon, Janet Wiseman, and Oren Frey '02

Recommendation:

* Establish an Environmental Field Station and Rustic Retreat

Background: There has been periodic discussion about a research and teaching field station for environmental studies over the years. During the Environmental Peak Retreat, an interest in a field station came up again. In addition, a desire to have a rustic retreat was also expressed. Therefore, the Environmental Peak Task Force established a subcommittee to determine if the need for a field station and a rustic retreat were justifiable.

Sallie Sheldon, who serves on the Peak Task Force, agreed to oversee this effort. Sallie sent a query to all ES Affiliated faculty about their interest in some sort of field facility. From those responding, she further requested information about when and how they might use such a facility.

Course use: Several faculty expressed interest in using a field station and rustic retreat for their courses (Table 1). The range of courses and faculty interest expressed from natural and physical science to the humanities reflect the diverse representation and interdisciplinary nature of the environmental studies program, a strength of Middlebury College's environmental program. Uses of a field facility run from studying water chemistry and ecological sampling to writing and reflection. Ten different courses were initially identified, although other faculty subsequently expressed additional interest including Young, Ryan and Churchill. The responses represented below indicate that many courses could utilize a field facility throughout the year without scheduling conflicts.

Table 1

Course	BI203	BI190	BI302	BI304	BI323	BI391	EL365	EL365	GG250	GG254
Lab/course size	14-18	15-18	24	8-14	12-14	8-12	12-15	12-15		
# of sections/wk	2	5	2	2	2	2	1	1	2	2
Weekday	y	y	n	y	y	n	y	y	y	y
Weekend	n	n	y	n	n	y	y	y	n	n
Term	f	f,s	f	f	f	f	f,wt,sp	f,wt,sp	s	f
Activity	collect	collect	collect	collect	collect	collect	retreat	retreat	lab	lab
Winterize?	n	n	y	n	n	y	y	y	y	y
		Lloyd/ Sheldon	Trombulak	McCabe		Sheldon	Elder	Mitchell	Bedford	Bedford

A number of faculty also suggested that if such a facility existed, they could use it for either their own research or student research. In addition, a desire was expressed to establish permanent, field research sites for long-term data collection, monitoring and analysis in proximity to the facility.

Other ES uses: Dan Bedford would consider installing a weather station with climatology instrumentation at such a site to record daily data. This use requires wiring so data can be sent directly to campus. Some people cite such a building for a summer program, but a summer program of the kind previously considered is not being actively discussed at this time. A field station may be an opportunity to rekindle the summer program discussion. However, the idea of a summer program is not driving the desire for a field station. Instead, academic year teaching and research are the programmatic needs supporting the concept of an ES field facility.

Field Station: In general, a building or buildings like the one at High Pond in Sudbury, now owned by the Nature Conservancy, would suit most faculty's desires for a research facility including: a winterized building with electricity and heat; running water; space for dry and wet labs; kitchen with adequate food storage and preparation space; all purpose room that could be used as a lecture room, seminar room, and a place to eat meals; student bunk rooms for 15-18; faculty bedrooms; rest rooms and showers; and adequate storage space for gear and equipment with some secure storage space.

Rustic Retreat: John Elder, Don Mitchell and others could make good use of a smaller, more rustic cabin for teaching, writing and reflection. It should be sited in a more isolated area farther into the woods or off in a field without disturbance from other activities. The cabin would require fewer modern amenities and be relatively inexpensive to build. Although a rustic cabin would be located in a more remote site, it should be only a modest distance from the research facility and from a secure parking area. It should be accessible by snowshoes or cross country skis during the winter months. A rustic cabin would be heated with a wood stove and not have electricity. It should by equipped with a small cook stove or dual purpose wood stove. It could include alternative technology, if appropriate. The cabin should accommodate approximately 12 people in a loft-style sleeping arrangement. Although the rustic structure would be located in a more remote site and serve as a stand alone, separate facility, it should be in proximity to the other research facility so the two can provide overflow sleeping space for one another with larger groups, or so the two facilities can be used together for programmatic purposes if desired. The idea of the two facilities has generated thoughts about creative interaction among faculty and courses.

Additional College use: According to Middlebury's student activities office, a rustic retreat would also be used for student outdoor leadership training and trips, providing even greater College utilization of such a facility. Building and developing a field station and rustic retreat would serve not only the ES Program, but other field-based courses at the College.

Location: At this point, a location in a wooded area of the Bread Loaf campus would be ideal for a teaching, research and reflective facility for environmental studies. Faculty, students and alumni readily identify with the Bread Loaf campus as being part of Middlebury College. The property has long been owned and operated by College and is unlikely to leave the College ownership, assuring that long-term research sites will be worth establishing. Bread Loaf also has a property caretaker and maintenance staff. The Bread Loaf campus is already a year round, multi-use facility used for a variety of purposes by the College and others for activities ranging from recreational and educational to lodging. It maintains enough regular activity and staff profile to discourage vandalism and deviant behavior that can plague field stations. The property is readily accessible year round. It is somewhat underutilized by the College for educational purposes during the academic year. The area contains diverse habitats and ecosystems that faculty have identified as being critical for their studies and teaching including: wetlands, aquatic systems, managed wood lots, natural forests, an old growth tree stand and open fields. The undisturbed US Forest Service Bread Loaf Wilderness area is within hiking distance, as are thousands off acres of additional Green Mountain National Forest land. Transects have been established in this area to study wildlife activity and are monitored by the Keeping Track Program, an activity in which ES students have been participating. Andi Lloyd has expressed an interest in establishing permanent research plots to study forest ecology in the recently certified, sustainable forest lands on 350 acres at Bread Loaf. Alternative sites have not been discussed because Bread Loaf meets the objectives identified by ES faculty and staff, but other locations should be considered if available, if ecologically diverse and if programmatic goals can be met.

Association of Field Stations: Once the College has approved a field station and rustic retreat, the ES Program should become a member of the Organization of Biological Field Stations (OBFS http://www.obfs.org). The OBFS is an association of 180 field stations and professionals concerned with field facilities for biological research and education, primarily in North America and Central America. The web site above provides links to OBFS member stations. Individual stations include descriptions of courses offered, summer internships, teacher education, etc. OBFS promotes the exchange of information and ideas among field stations on such topics as management of field stations and reserves, promotion of biological field education and research, environmental monitoring, and funding opportunities. OBFS publishes a newsletter, occasional reports, a field course opportunities poster, and a directory of field stations. An annual meeting is held at a member facility in September, providing a forum for discussion of field station management issues and organization business, and an opportunity to learn from the facilities, habitats and programs of the host station.

Program: A detailed program including scientific equipment should be developed for the environmental field station and rural retreat. Discussions must also take place regarding the management of the field station and rustic retreat and staff implications.

Appendix 5. Inventories to Undertake

Further wind testing with heated anemometer
Solar inventory similar to that conducted by Vandal ’07 (requires DEM with buildings)
Micro hydro testing by professionals
Geothermal testing by professionals
Biomass testing by professionals
Ecosystem service testing (could be valuing ecosystem services through an economics class)
Historical inventory, including cellar holes, foundations and stone walls
Comprehensive forest conservation plan through VFF
Carbon inventory
Biological inventory

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